AD-A038 142 SYRACUSE UNIV N Y DEPT OF ELECTRICAL AND COMPUTER E--ETC F/G 9/5
ANTENNA PATTERN DISTORTION COMPUTER PROGRAM,(U)
JAN 77 J PERINI, K HIRASAWA F30602-75-C-0121

UNCLASSIFIED RADC-TR-77-35 NL

| OF |
AD
A038142

END

DATE
FILMED
4-77

(12)

RADC-TR-77-35
Phase Report
January 1977

ANTENNA PATTERN DISTORTION COMPUTER PROGRAM

Syracuse University

Approved for public release;
distribution unlimited.

ROME AIR DEVELOPMENT CENTER
AIR FORCE SYSTEMS COMMAND
GRIFFISS AIR FORCE BASE, NEW YORK 13441

This report contains a large percentage of machine-produced copy which is not of the highest printing quality but because of economical consideration, it was determined in the best interest of the government that they be used in this publication.

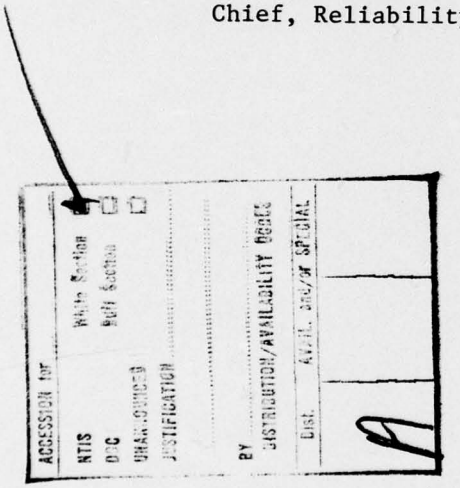
This report has been reviewed by the RADC Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be releasable to the general public, including foreign nations.

This report has been reviewed and approved for publication.

APPROVED: Jacob Scherer
JACOB SCHERER
Project Engineer

APPROVED: Joseph J. Naresky
JOSEPH J. NARESKY
Chief, Reliability and Compatibility Division

FOR THE COMMANDER: John P. Huss
JOHN P. HUSS
Acting Chief, Plans Office



Do not return this copy. Retain or destroy.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER RADC-TR-77-35	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* ANTENNA PATTERN DISTORTION COMPUTER PROGRAM		5. TYPE OF REPORT & PERIOD COVERED Phase Report
		6. PERFORMING ORG. REPORT NUMBER N/A
7. AUTHOR(s) Dr. Jose Perini Dr. Kazuhiro Hirasawa		8. CONTRACT OR GRANT NUMBER(s) F30602-75-C-0121
9. PERFORMING ORGANIZATION NAME AND ADDRESS Syracuse University Syracuse NY 13210		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS ~~95670016~~ 09
11. CONTROLLING OFFICE NAME AND ADDRESS Rome Air Development Center (RBC) Griffiss AFB NY 13441		12. REPORT DATE Jan~~uary~~ 1977 13. NUMBER OF PAGES 58
14. MONITORING AGENCY NAME & ~~ADDRESS(if different from~~ Controlling Office) Same		15. SECURITY CLASS. *(of this report)* UNCLASSIFIED 15a. DECLASSIFICATION DOWNGRADING SCHEDULE N/A

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

Same

18. SUPPLEMENTARY NOTES

RADC Project Engineer: Jacob Scherer (RBC)

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Electromagnetic Compatibility
Electromagnetic Fields
Antennas
Antenna Pattern

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The Antenna Pattern Distortion Computer Program is a user oriented code that allows the engineer designing a communication antenna farm to easily enter the antennas involved by simply calling their AF number (AT1181, AT1097, AT197, and a lightning rod LR1000) and specifying their location on an arbitrary reference plane. This reformer plane may be specified as a perfectly conducting infinite ground plane if desired. The program output may be any specified horizontal or vertical pattern. It can also calculate the mutual coupling between any two

over

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

406737

antennas. If the information provided by the AFCS SCREEN is available, the program can provide plots of the communication range of station when the antenna pattern, antenna power, terrain topography, and receiver sensitivity are specified for any specified aircraft altitude.

PREFACE

This effort was conducted by Syracuse University under the sponsorship of the Rome Air Development Center Post-Doctoral Program for Air Force Communications Service (AFCS). Mr. Robert Feik and Mr. Y.S. Fu were the AFCS focal points and provided overall technical direction and guidance. The author of this report is Dr. Jose Perini, and the co-author is Dr. Kazuhiro Hirasawa.

The RADC Post-Doctoral Program is a cooperative venture between RADC and some sixty-five universities eligible to participate in the program. Syracuse University (Department of Electrical and Computer Engineering), Purdue University (School of Electrical Engineering), Georgia Institute of Technology (School of Electrical Engineering), and State University of New York at Buffalo (Department of Electrical Engineering) act as prime contractor schools with other schools participating via sub-contracts with the prime schools. The U.S. Air Force Academy (Department of Electrical Engineering), Air Force Institute of Technology (Department Of Electrical Engineering), and the Naval Post Graduate School (Department of Electrical Engineering) also participate in the program.

The Post-Doctoral Program provides an opportunity for faculty at participating universities to spend up to one year full time on exploratory development and problem-solving efforts with the post-doctorals splitting their time between the customer location and their educational institutions. The program is totally customer-funded with current projects

being undertaken for Rome Air Development Center (RADC), Space and Missile Systems Organization (SAMSO), Aeronautical Systems Division (ASD), Electronic Systems Division (ESD), Air Force Avionics Laboratory (AFAL), Foreign Technology Division (FTD), Air Force Weapons Laboratory (AFWL), Armament Development and Test Center (ADTC), Air Force Communications Service (AFCS), Aerospace Defense Command (ADC), Hq USAF, Defense Communications Agency (DCA), Navy, Army, Aerospace Medical Division (AMD), and Federal Aviation Administration (FAA).

Further information about the RADC Post-Doctoral Program can be obtained from Jacob Scherer, RADC/RBC, Griffiss AFB, NY, 13441, telephone AV 587-2543, COMM (315) 330-2543.

The author, Dr. Jose Perini, received his B.S. degree from Escola Politécnica de São Paulo, S.P., Brazil (1952) and his Ph.D. degree from Syracuse University (1961). He joined the faculty of Syracuse University in 1962 as Assistant Professor of Electrical Engineering, advanced to Associate Professor in 1966, and to Professor in 1971. Prior to his affiliation with Syracuse University, Dr. Perini served as Assistant Professor of Electrical Engineering at Escola Politécnia de São Paulo and as Manager of the Radio Maintenance Department of Real Transportes Aereos in São Paulo. He is a consultant to the General Electric Company and Data Functions Corporation. Dr. Perini teaches graduate courses and supervises graduate student research for M.S. and Ph.D. degrees and was Director of the Syracuse University Graduate Center at Poughkeepsie from 1966 to 1968. His publications cover topics in television antennas,

fields and propagation, and signal-processing aspects of electromagnetic compatibility. He holds two antenna patents and is a member of the Institute of Electrical and Electronics Engineers.

Dr. Kazuhiro Hirasawa, the co-author, was born in Tochigi, Japan, on December 5, 1941. He received the B.S. and M.S. degrees in Electrical Engineering from Keio University, Tokyo, Japan in 1964 and 1966 respectively and the Ph.D. degree in Electrical Engineering from Syracuse University in 1971. At present he is a research Engineer in the Department of Electrical and Computer Engineering, Syracuse University.

The author wishes to acknowledge: the contributions of Dr. W.W. Everett of the RADC Post-Doctoral Program for effort during the course of the work, and in drafting the final report; the contributions of Mr. Robert Feik and Mr. Y.S Fu throughout the entire effort; Mr. Dave Pierce and Mr. Sam Zaccari for management support; Mrs. Colleen Hart, Ms. Lyn Swingle, and Mrs. Ann Buckley for administrative support and final draft preparation.

TABLE OF CONTENTS

LIST OF FIGURES

ANTENNA PATTERN DISTORTION COMPUTER PROGRAM

1. Introduction

Presently, when a new communication facility is designed, there is no simple way that the project engineer can predict the interaction between the many antennas that will be present in the facility. The available rules of thumb are too crude and do not really give any detailed information of the antenna pattern distortion or mutual coupling effects. Recent developments in the area of computer aided design of antennas allowed the development of a user oriented computer program that can perform an accurate analysis of existing or future antenna installations with far more detail than has been possible. The description and usage of this program is the subject of this report.

2. Physical Layout of the Antenna Farm

A system of rectangular coordinates x, y, z will be used for specifying the position of the antennas in the installation as shown in Figures 1 and 2. The vertical axis is always z and the x, y axes define a reference plane which must coincide with the installation ground plane if there is one. In this case the z_i are the heights of the base of each antenna above the ground plane. In cases where no ground plane is used, the axis x, y define an arbitrary reference plane and the z_i are the heights of the base of each antenna above this plane. When we refer to a ground plane here, we mean a metallic structure, either solid or in the form of a wire mesh of sufficiently small openings to act as a ground plane. The earth below the antenna installation is ignored by the program because usually the antennas are high

enough above the terrain. In order to control the patterns of the antennas on the installation, it is advisable to always use a ground plane extending at least four to five feet beyond the outermost antennas.

As will be described in detail later, the program has two versions: (1) a simplified one where only the antenna types have to be specified and (2) a general one where the actual dimensions of each antenna have to be specified.

Figure 1 shows the input variables for the simplified program. As can be seen, only the type (AT 1181, AT 1097, AT 197, or LR 1000 - lightning rod) and the x_i, y_i, z_i coordinates specifying the antenna positions are required.

Figure 2 shows the input variables for the general program. Besides the position x_i, y_i, z_i of each antenna, we also have to specify the antenna lengths h_i, the radii r_i, the positions of any loads ℓ_i if they exist, the loads Z_i, as well as the feed positions f_i.

In the simplified program only one antenna can be fed at a time and no loads are allowed in the other antennas which are assumed terminated by their nominal input impedances. In the general program, all antennas may be fed and can also carry one load each. This will allow the solution of more general problems such as antenna arrays or special types of antennas not included in the simplified program catalog.

3. Description of the Computer Program

This program was designed to be used with the Honeywell 635 computer, based at RADC, via remote terminal. It was written in FORTRAN IV languate and therefore can be easily adapted to many other computers.

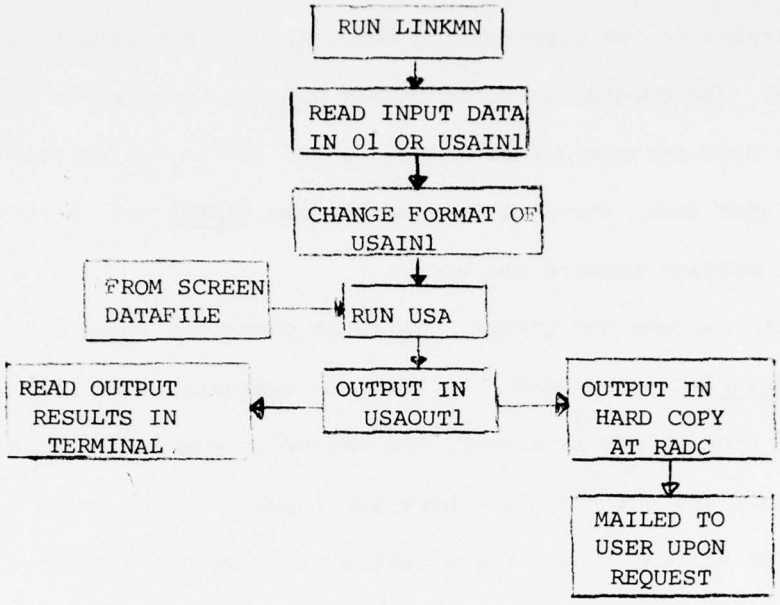
The program is executed in two phases. The first, which is called LINKMN and operates in the Time-Sharing Mode, is used for inputting all the pertinent data. The second, which is called USA and operates in the Remote Batch Mode, is used for the actual computations. If any detectable errors occur in the input data, the Time-Sharing Program LINKMN will detect them and print an error message warning the user.

In order to execute the program USA three permanent files called USAIN1, USAOUT1, and DATAFILE are needed. As the name suggests, the first is where the input data from LINKMN is stored, the second is where the program will write its output, and the third is where the input data for communication range contour is stored. These files have already been created and are part of the RADC program package. Presently, USAIN1 and USAOUT1 are 4 and 8 blocks* long respectively, and DATAFILE is a random file (20 blocks long). This has shown to be large enough for the cases treated in this report. If more runs are needed, the size of the files may have to be increased.

After the input data is read in USAIN1 by LINKMN, the data is changed into the proper format and stored again in USAIN1. After the program USA is executed, the results will be in USAOUT1 and have to be read in the terminal. Examples of these manipulations are given in the next sections. If the communications contour is to be computed the appropriate topographic data has to be in DATAFILE by running the SCREEN program. The following block diagram summarizes the above discussion:

---

*One block is equal to 320 thirty two bit words.



If an unusually large problem is being run where, for example, a lot of mutual coupling coefficients are printed, the data may exceed the capacity of USAOUT1. In this case a message will be printed out and part of the output will be lost, and the size of the file USAOUT1 has to be increased.

As mentioned earlier, the input program LINKMN has been written with two options. The first, called the "SIMPLE PROGRAM", does not require any knowledge whatsoever of the limitations of the numerical technique used. The terminal requests very simple and straightforward questions and no decisions have to made by the user. Presently, three types of commonly used AF antennas and lightning rods are allowed as input: the VHF AT 1181, the UHF AT 1097, the UHF AT 197, and the LR 1000 (a designation reserved by us to a lightning rod). In this option only the antenna whose pattern is being

computed can be fed. The second option, called the "GENERAL PROGRAM", allows the treatment of any vertical cylindrical antenna with a maximum radius of 0.1 having, at most, one feed point and one load per antenna. This option cannot compute communication contours.

If desired, the mutual coupling coefficients among the various antennas can be computed and printed out in dB when using the SIMPLE PROGRAM.

The program will also compute vertical (constant $\emptyset$) and horizontal (constant θ) patterns. The increments $\Delta\theta$ and $\Delta\emptyset$ can be specified by the user. The conventional horizontal pattern is therefore computed for $\theta = 90^{\circ}$, the horizontal plane, but if desired, any polar angle θ can be specified. When patterns are computed, the output will be in normalized magnitude expressed in ration (NMAG) and in dB (NMAGDB). The value of the field used for the normalization is printed out under EMAX and the gain of the antenna in the direction of EMAX (over the isotropic source) is also printed out as a ratio (GAIN) and in dB (GAINDB).

The program will also compute communication range contours for specified signal levels for up to six different airplane heights. The ranges are expressed in nautical miles.

After all the input data is fed to LINKMN, it prints out all the data as read by the computer for cross reference purposes and then gives the size of the arrays and the amount of core needed to run USA. These last two pieces of information have to be fed into USA prior to running as shown in the examples of the next sections. The purpose of this procedure is to use as

little core as possible in order to decrease the turn-around-time. If the required core exceeds 60K, a special statement is used to advise the operator and thus facilitate the execution.

In the next section we present some examples of use of this program with detailed explanations of all procedures.

NOTE: When this program is first installed in a new computer, the program LINKMN has to be run in a special way to create the necessary files for its normal execution in all other runs. LINKMN has been partitioned into four programs: LINKMN, LINKM1, LINKM2, and LINKM3 which perform different functions, and are loaded only when needed.

The following commands should be used:

```
SYSTEM ?FORT
OLD OR NEW-NEW
READY
*RUN LINKM1=;L1(NOGO)   (+)
*RUN LINKM2=;L2(NOGO)
*RUN LINKM3=;L3(NOGO)
*RUN LINKMN=;LM(NOGO)
*RUNL LM=HS;LINK(LINK1)L1;LINK(LINK2,LINK1)L@;LINK(LINK#,LINK2)L3
```

The first four RUN commands automatically create the necessary permanent files L1, L2, L3, and LM, and store the respective programs there. These four files require a total of 26 blocks of file space. The last RUNL command creates the necessary temporary file HS automatically. If desired, a permanent random file HS (43 blocks in size) can be created before the RUNL command, and the whole program stored permanently in object form for future runs.

After these steps type

RUN HS #USAIN1 "01"

Then program will start asking questions.

The random file named DATAFILE has to be created and all the necessary "Line of Sight Coverage" data has to be stored there before the program USA is run in the CARDIN system. The name DATAFILE can be changed to any name desired by modifying statement 5025 in the program USA to 5025$:PRMFL:03,R/W,R,BLA00001/XXX... where XXX... is the new name (maximum of eight characters). This modification should be done when lines 50, 500, 5000 are modified. See Example 4, note number 8.

4. *Examples of Program Use*

In the listings that follow, CR means a carriage return entered by the user. Numbers on the left-hand side margin are references to explanations that follow the run. All user responses are underlined.

The answers to the terminal questions are either numbers or words such as YES, NO, INCHES, METERS, etc. Whenever this last type of answer is requested, the user can type the whole word or just the first letter. In any event the computer recognizes only the first letter. Therefore, Y, YES, YNO are all interpreted as YES since the first letter is a Y. No blanks are allowed before the word. For example _YES (where _ is a blank) will be detected as an error and the question will be repeated again after the message: ".....INPUT ERROR, TRY AGAIN....." is typed in the terminal.

(+) For more details see Honeywell Series 600/6000, FORTRAN, Manual number BJ67, p. 3 - 22.

The computer does not take any answer until a carriage return (CR) is entered. Therefore, if an input error is detected before the CR, two procedures can be used to correct it [1]:

(a) If the whole line is to be deleted, press simultaneously the CTRL and X keys. The computer will print DEL indicating that the whole entry has been deleted and skips to the next line waiting for the line to be re-entered.

EX:

ANTENNA POSITION X Y Z

= 100,10,0 CR

(b) If only a few characters have to be corrected, press SHIFT and @ as many times as there are characters to be corrected.

EX:

ABD@CD is read as ABCD

AB_C@@CD is read as ABCD

N@Y is read as Y

---

[1] For more detailed information, see GE-600 Line GECOS III Time-Sharing FØRTRAN, manual #CPB - 1566A, Now Honeywell BR 70.

4.1 EXAMPLE 1 - In this example many errors were introduced on purpose to exercise as much as possible the error detection capability of the program.

```
CR
0110301

RADC R&D TSS GCOS-GU3 07/16/76 AT  9.893  CHANNEL 3030


LOGON ID-BLA00001;956700160409
PASSWORD--
1 [illegible]

2 SYSTEM ?FORT
3 OLD OR NEW-NEW
READY
4 *RUN HS #USAIN1 "01"
+++++ ENTER ANTENNA PARAMETERS +++++

5  DIMENSIONS IN METERS OR INCHES ?
=N
6 ..... INPUT ERROR, TRY AGAIN .....
7  DIMENSIONS IN METERS OR INCHES ?
8 = M
..... INPUT ERROR, TRY AGAIN .....
 DIMENSIONS, IN METERS OR INCHES ?
9 =M
 GROUND PLANE ?
=YES
10  SIMPLE PROG ?
=Y
 COUPLING COEFFICIENTS ?
=NO
 NUMBER OF ANTENNAS
=4
****  ANTENNA NUMBER  1  ****
 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
11 =1197
..... INPUT ERROR, TRY AGAIN .....
 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
12 =1097
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
13 =1., DEL
0.,0.,0.
****  ANTENNA NUMBER  2  ****
 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
14 =1182
..... INPUT ERROR, TRY AGAIN .....
 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
15 =1183@1
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=0.,1.,0.
```

```
**** ANTENNA NUMBER 3 ****
 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=1000
 LENGTH
=2.
 DIAMETER
=.009
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=1.,0.,0.
**** ANTENNA NUMBER 4 ****
 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=197
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=-1.,0.,0.
+++ RADIATION PATTERN +++
 VERTICAL PATTERN ?
=NO
 HORIZONTAL PATTERN ?
=NO
 COMMUNICATION RANGE CONTOUR ?
=NO
..... INPUT ERROR, TRY AGAIN .....
16 VERTICAL PATTERN ?
=NO
 HORIZONTAL PATTERN ?
=YES
 THETA (DEGREES)
=90
 90
17  ^
FILE CODE 41 ILLEGAL CHAR; CORRECTION =0
18 PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=0
..... INPUT ERROR, TRY AGAIN .....
 PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=10.
 COMMUNICATION RANGE CONTOUR ?
=NO

 NUMBER OF RUNS
=1
**** RUN # 1 ****
 FREQUENCY (MHZ)
=127
 FED ANTENNA (#)
19 =5
..... INPUT ERROR, TRY AGAIN .....
 FED ANTENNA (#)
20 =1
..... INPUT ERROR, TRY AGAIN .....
 FREQUENCY (MHZ)
=127
 FED ANTENNA (#)
21 =3
..... INPUT ERROR, TRY AGAIN .....
 FED ANTENNA (#)
=2
```

```
22 DIM= M  GP= Y  SIMP= Y  COUPL= N  NR=  4
   ANT# =      1        2        3        4
   TYPE =   1097     1181     1000      197
   X    =   0.      0.       1.000   -1.000
   Y    =   0.      1.000    0.       0.
   Z    =   0.      0.       0.       0.
   L    =   0.      0.       2.000    0.
   D    =   0.      0.       0.009    0.
   VER PAT=  N
   HOR PAT=  Y
   THETA=  90.0  PLOT INC=  10.00
   COM RNG=  N


   RUN#      FREQ(MHZ)  ANT FED(#)
     1        127.00        2


23 +++  62 X 62 IS THE MIN DIM FOR C1, C2 +++
   +++  27 K IS THE MIN MEMORY NEEDED +++

24 *REMOVE  01
   *OLD USAIN1
25 READY
   *ASCBCD *;USAIN1
26 LABELS?
   TAB CHARACTERS AND SETTING?
27 *SYST CARD
   OLD OR NEW-OLD USA
   READY
28 *50   CR
   *500:DIMENSION C1(62,62),C2(62,62)
29 *5000$:LIMITS
   *5000$:LIMITS:15,27K
30 *LISTS 50,500,5000


   500:DIMENSION C1(62,62),C2(62,62)
   5000$:LIMITS:15,27K

   READY

31 *RUN
32   SNUB # 6818T
   CARD FORMAT,DISPOSITION ?
33 NORM
34 *JSTS 6818T
35 6818T-01 TOO BIG
36 *BYE
   **COST:  $   1.66 TO DATE:  $  377.50=  8%
   **ON AT  9.892 - OFF AT 10.102 ON  07/16/76
```

```
37 *BCDASC USAOUT1;*
38 LINE NUMBERS?
   TAB CHARACTERS AND SETTING?
39 *LIST


40  *** ANT# (FED)=  2  FREQ (MHZ)= 127.00 ***

    HORIZONTAL PATTERN

    THETA=    90.0

    EMAX=    0.274 GAIN=   2.891 GAIN(DB)=   4.61

     PHI      NMAG      NMAG(DB)
      0.     0.8460      -1.45
     10.     0.7352      -2.67
     20.     0.6124      -4.26
     30.     0.4981      -6.05
     40.     0.4141      -7.66
     50.     0.3737      -8.55
     60.     0.3696      -8.65
     70.     0.3807      -8.39
     80.     0.3899      -8.18
     90.     0.3927      -8.12
    100.     0.3965      -8.03
    110.     0.4127      -7.69
    120.     0.4451      -7.03
    130.     0.4893      -6.21
    140.     0.5424      -5.31
    150.     0.6084      -4.32
    160.     0.6903      -3.22
    170.     0.7807      -2.15
    180.     0.8627      -1.28
    190.     0.9184      -0.74
    200.     0.9368      -0.57
    210.     0.9172      -0.75
    220.     0.8674      -1.24
    230.     0.8012      -1.93
    240.     0.7347      -2.68
    250.     0.6839      -3.30
    260.     0.6616      -3.59
    270.     0.6749      -3.41
    280.     0.7224      -2.82
    290.     0.7933      -2.01
    300.     0.8712      -1.20
    310.     0.9391      -0.55
    320.     0.9844      -0.14
    330.     1.0000       0.
    340.     0.9825      -0.15
    350.     0.9307      -0.62
    360.     0.8460      -1.45

   READY

41 *BYE
   **COST:  $    0.47 TO DATE:  $  390.39=  8%
   **ON AT 14.370 - OFF AT 14.440 ON  07/16/76
```

Explanation of Example 1

1. Sign on procedure - the user enters the USER ID and PASSWORD (masked on purpose). After any entry, always enter a CR to indicate that the input is completed.
2. Request the system TFORT.
3. Call NEW since the program is in objet form in HS.
4. Request that the program HS be RUN and the output be stored in the file 01 which is the alternate name of the file USAIN1, since only numbers can be used as a file name in the system FORT. HS then starts asking questions from the user.
5. The answer to "DIMENSIONS IN METERS OR INCHES" has to be any of the following: M, METERS, I, INCHES. In this case, N was inadvertently entered.
6. The program does not recognize the answer and requests that the information be entered again.
7. Note that the computer repeats the question.
8. Again, inadvertently, a blank was entered before M and the computer rejects the input again.
9. Finally, the correct input is entered.
10. Note that YES and Y are acceptable answers.
11. A mistake in the antenna type is made.
12. The correct answer is entered.
13. In this case the user detected an error (1., instead of zero was

entered) and the input was cancelled by depressing simultaneously the keys CTRL and X. The computer prints DEL indicating that the information was deleted, skips to the next line and waits for the line to be typed over.

14. Again an input error is detected by the computer.

15. This is an example of how to correct only a few characters. The @ erased the 3 which was replaced by the 1 entered after.

16. This message is issued because this run has no output since NO COUPLING COEFFICIENTS were requested at the beginning and NO VERTICAL, HORIZONTAL PATTERNS or COMMUNICATION RANGE CONTOUR were requested now. At least one of these three answers has to be YES. Note that the computer asks the questions again.

17. A common mistake is to type the letter "O" instead of zero (Ø). The computer detected that 90 was entered instead of 9Ø.

18. The plotting increment has to be non-zero number; thus, the next two error messages.

19. The antenna specified does not exist since we have only four antennas.

20. Antenna 1 is UHF and the frequency specified is VHF, so the question FREQUENCY and FED ANTENNA are repeated.

21. Antenna 3 is a lightning rod and there is no feed.

22. This is a printout of what was just read in the computer for the user's verification. Take a moment to double check this, otherwise the whole run may be wasted. Note that the type of ANTENNA NUMBER 2 has been

corrected to 1181. DIM = M means dimensions in meters. The other answers are self explanatory.

23. This is needed information to run USA so that the minimum array sizes (62 x 62) and the minimum memory requirements (27K) are used.

24. This statement is to remove the file 01 from AFT so that access to USAIN1 can be regained.

25. These statements are used to change the data in USAIN1 from ASCII to BCD for use by USA.

26. Note the CR entered as answers to the next two questions, since no labels or tab settings are required.

27. As USA is in the Remote Batch Mode (called CARDIN) the CARDIN system is requested, followed by a call of the OLD USA program.

28. Statements 50, 500, and 5000 are modified to the present size as indicated in 23 above. The explanation of each statement is as follows [2]:

    (a) Statement 50 is used to warn the operator that a large program is coming. This should be used whenever the run size is greater than 60K. The format is the following:

    Less than 60K

        50CR

    More than 60K

        50$:MSG1:1,(MESSAGE)

    EX: 50$MSG1:1, THIS RUN REQUIRES 71K

(b) Statement 500 modifies the dimensions of all the arrays in USA. The format is:

500:DIMENSION C1(NN,NN), C2(NN,NN)

where NN is the value indicated in 23 above by the message

+ + + NN x NN IS THE MIN DIM FOR C1, C2 + + +

EX: 500:DIMENSION C1,(62,62), C2(62,62)

(c) Statement 5000 specifies a running time limit and states the core requirements to run USA.

5000$:LIMITS:XX,YYK

where XX is an estimate of the running time in hundredths of an hour.

YY is the required memory in 1000 words

EX: 5000$:LIMITS:15,48K (.15 hours max run time)

29. If an error is detected (as in this case due to misspelling of LIMITS), just press CR and start the line again. Whenever the same line number is entered more than once, the computer will only use the information typed in the last time.

30. It is a good practice to request the computer to list the statements just entered. This can be done by the command LISTS NN,MM,PP... This will list only the specified statement numbers. Note also that statement 50 was not listed, since it is a blank now.

31. After the modifications above are verified to be correct, USA is asked to RUN.

32. The CARDIN system will assign a number to this specific run. In this case 6818T.

33. Answer NORMAL or NORM to the next question as no special card disposition is used.

34. This is a request of the status of your job. JSTS 6818T means what is the JOB STATUS of 6818T.

35. In this case, the answer was that the program STATUS was TOO BIG. The normal procedure is to disconnect the terminal and sometime later request JSTS 6818T. In case the job is small, it is possible that it will be run after a short time and therefore you may wish to keep the terminal on. Periodically, request your job status, since if the terminal is inactive for more than 10 minutes, it will be automatically disconnected.

36. BYE is the message to disconnect the terminal. If at a later time the user requests the job status and the computer replied that the job is completed with NORMAL TERMINATION, the following procedure is used to retrieve the output data:

37. The output is in file USAOUT1 but is in BCD. The user has to convert the data to ASCII. This is accomplished by this statement which reads BCD from USAOUT1, converts to ASCII and stores it in the present file which is indicated by the asterisk(*).

38. As no line numbers or tabs are required, answer the next two questions with a CR.

39. Request a listing of the present file.

40. The desired output is printed out. Note that the angle PHI is measured clockwise from the x-axis to conform with the azimuths of SCREEN. (See Figs. 1, 2). Note also that the magnitude of the radiation pattern is listed in ratio, as well as in DB normalized to EMAX, its maximum magnitude. The gain over the isotropic source in the direction of EMAX is also given in ratio and in DB.

41. After the listing is completed, just sign out.

NOTE: As a reference, this run took a total of 0.0246 hours, out of which .0016 hours were used for compilation. This information can be obtained from the full printouts that come out at RADC.

4.2 EXAMPLE 2 - In this example the use of multiple runs and an output with mutual couplings are illustrated.

```
SYSTEM ?FORT
OLD OR NEW-NEW
READY
*RUN HS #USAINI "01"
+++++ ENTER ANTENNA PARAMETERS +++++

 DIMENSIONS IN METERS OR INCHES ?
=I
 GROUND PLANE ?
=NO
 SIMPLE PROG ?
=YES
1  COUPLING COEFFICIENTS ?
=YES
 NUMBER OF ANTENNAS
=3
**** ANTENNA NUMBER  1 ****
 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=1181
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=0.,36.,0.
**** ANTENNA NUMBER  2 ****
 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=1097
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=0.,0.,0.
**** ANTENNA NUMBER  3 ****
 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=197
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=-36.,0.,0.
+++ RADIATION PATTERN +++
 VERTICAL PATTERN ?
=YES
 PHI (DEGREES)
=0.
 PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=10.
 HORIZONTAL PATTERN ?
=YES
 THETA (DEGREES)
=90.
 PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=15.
 COMMUNICATION RANGE CONTOUR ?
=NO

2  NUMBER OF RUNS
=2
**** RUN #  1 ****
 FREQUENCY (MHZ)
=118.5
 FED ANTENNA (#)
=1
```

```
**** RUN #  2 ****
 FREQUENCY (MHZ)
=400.
 FED ANTENNA (#)
=3


3 DIM= I  GP= N  SIMP= Y  COUPL= Y  NR=  3
  ANT# =      1        2        3
  TYPE =    1181     1097      197
  X    =     0.       0.    -36.000
  Y    =   36.000     0.       0.
  Z    =     0.       0.       0.
  VER PAT=  Y
  PHI  =    0.    PLOT INC=   10.00
  HOR PAT=  Y
  THETA=   90.0   PLOT INC=   15.00
  COM RNG=  N


  RUN#      FREQ(MHZ)   ANT FED(#)
    1        118.50         1
    2        400.00         3


4 +++  72 X 72 IS THE MIN DIM FOR C1, C2 +++
  +++  29 K IS THE MIN MEMORY NEEDED +++

  *REMOVE  01
  *OLD USAIN1
  READY
  *ASCBCD *;USAIN1
  LABELS?
  TAB CHARACTERS AND SETTING?
  *SYSTEM CARD
  OLD OR NEW-OLD USA
  READY
  *50
  *500       DIMENSION C1(72,72),C2(72,72)
  *5000$:LIMITS:10,29K
  *LISTS 50,500,5000

  500       DIMENSION C1(72,72),C2(72,72)
  5000$:LIMITS:10,29K

  READY

  *RUN
    SNUMB # 3000T
  CARD FORMAT,DISPOSITION ?
  NORM
  *JSTS 3000T
  3000T-01 TOO BIG
  *BYE
  **COST:  $   1.49 TO DATE:  $  250.56=  5%
  **ON AT 14.835 - OFF AT 15.012 ON  07/13/76
```

```
5  *JSTS 3000T
   3000T     OUTPUT WAITING
   IF LAST JOB SUBMITTED, STATUS WAS:
   NORMAL TERMINATION

   *BCDASC USAOUT1;* CR
   LINE NUMBERS? CR
   TAB CHARACTERS AND SETTING? CR
   *LIST


6  *** ANT# (FED)=  1  FREQ (MHZ)= 118.50 ***


7  COUPLING COEFFICIENT

   ANTENNA NO.      POWER RECEIVED (DB)
       2                  -17.06
       3                  -32.92


   VERTICAL PATTERN

   PHI=     0.

   EMAX=    0.613 GAIN=  1.367 GAIN(DB)=  1.36

   THETA     NMAG      NMAG(DB)
     0.     0.0082     -41.71
    10.     0.1152     -18.77
    20.     0.2437     -12.26
    30.     0.3751      -8.52
    40.     0.5044      -5.94
    50.     0.6254      -4.08
    60.     0.7341      -2.68
    70.     0.8301      -1.62
    80.     0.9127      -0.79
    90.     0.9743      -0.23
   100.     1.0000       0.
   110.     0.9762      -0.21
   120.     0.9010      -0.91
   130.     0.7842      -2.11
   140.     0.6410      -3.86
   150.     0.4850      -6.28
   160.     0.3253      -9.75
   170.     0.1658     -15.61
   180.     0.0085     -41.42
```

HORIZONTAL PATTERN

THETA= 90.0

EMAX= 0.771 GAIN= 2.166 GAIN(DB)= 3.36

PHI	NMAG	NMAG(DB)
0.	0.7739	-2.23
15.	0.7606	-2.38
30.	0.7792	-2.17
45.	0.8145	-1.78
60.	0.8550	-1.36
75.	0.8923	-0.99
90.	0.9171	-0.75
105.	0.9211	-0.71
120.	0.9006	-0.91
135.	0.8576	-1.33
150.	0.8026	-1.91
165.	0.7576	-2.41
180.	0.7479	-2.52
195.	0.7811	-2.15
210.	0.8413	-1.50
225.	0.9060	-0.86
240.	0.9583	-0.37
255.	0.9896	-0.09
270.	1.0000	0.
285.	0.9940	-0.05
300.	0.9738	-0.23
315.	0.9371	-0.56
330.	0.8829	-1.08
345.	0.8210	-1.71
360.	0.7739	-2.23

8 *** ANT# (FED)= 3 FREQ (MHZ)= 400.00 ***

COUPLING COEFFICIENT

ANTENNA NO.	POWER RECEIVED (DB)
1	-31.44
2	-16.96

VERTICAL PATTERN

PHI= 0.

EMAX= 0.765 GAIN= 2.441 GAIN(DB)= 3.87

THETA	NMAG	NMAG(DB)
0.	0.0000	-1000.00
10.	0.0801	-21.92
20.	0.2022	-13.88
30.	0.3516	-9.08
40.	0.4706	-6.55
50.	0.5512	-5.17
60.	0.6490	-3.76
70.	0.7303	-2.73
80.	0.8485	-1.43
90.	0.9409	-0.53
100.	1.0000	0.
110.	0.9781	-0.19
120.	0.8409	-1.51
130.	0.7586	-2.40
140.	0.6858	-3.28
150.	0.5570	-5.08
160.	0.4140	-7.66
170.	0.2232	-13.03
180.	0.0000	-1000.00

HORIZONTAL PATTERN

THETA= 90.0

EMAX= 0.971 GAIN= 3.933 GAIN(DB)= 5.95

PHI	NMAG	NMAG(DB)
0.	0.7412	-2.60
15.	0.7226	-2.82
30.	0.2994	-10.48
45.	0.8150	-1.78
60.	0.7041	-3.05
75.	1.0000	0.
90.	0.3722	-8.59
105.	0.7194	-2.86
120.	0.8505	-1.41
135.	0.5587	-5.06
150.	0.6341	-3.96
165.	0.5701	-4.88
180.	0.6243	-4.09
195.	0.9672	-0.29
210.	0.2934	-10.65
225.	0.7467	-2.54
240.	0.6771	-3.39
255.	0.9165	-0.76
270.	0.6596	-3.61
285.	0.5177	-5.72
300.	0.7129	-2.94
315.	0.4026	-7.90
330.	0.2257	-12.93
345.	0.2796	-11.07
360.	0.7412	-2.60

Explanation of Example 2

1. Note that the coupling coefficients have been requested.
2. Note the specification of two runs. For every run the number of the fed antenna, as well as the frequency, is requested.
3. Note DIM = I, which means dimensions in Inches.
4. Only 29K is needed with (72 x 72) arrays.
5. At a later time it was found that the job had a normal termination and the user proceeded to print out the output file.
6. Before listing the data, the antenna fed and the frequency are specified.
7. The mutual coupling coefficient is defined as the ratio of the received power at any specified antenna (terminated by 5052 in the SIMPLE PROGRAM) to the input power of the fed antenna.
8. This is the beginning of the listing for the second run.

NOTE: As a reference, this run took a total of 0.0353 hours, out of which .0016 hours were used for compilation.

4.3 EXAMPLE 3 - This example illustrates the use of the general program option. Note the detailed input information required.

```
SYSTEM ?FORT
OLD OR NEW-NEW
READY
*RUN HS #USAIN1 "01"
+++++ ENTER ANTENNA PARAMETERS +++++

 DIMENSIONS IN METERS OR INCHES ?
=M
 GROUND PLANE ?
=NO
 SIMPLE PROG ?
=N
 FREQUENCY (MHZ)
=125.
 NUMBER OF ANTENNAS
=3
 1  AUTO SPEC #SEGS ?
=Y
**** ANTENNA NUMBER  1  ****
 ANTENNA LENGTH
=1.
 2  LOAD POSITION
=0
 FEED POSITION
=.5
 3  ANTENNA RADIUS
=.3
..... INPUT ERROR, TRY AGAIN .....
 ANTENNA RADIUS
=.02
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=0.,0.,0.
 4  FEED VOLTAGE (REAL,IMAG)
=1.,0.
 5  LOAD IMPEDANCE (REAL,IMAG)
=0,0
**** ANTENNA NUMBER  2  ****
 ANTENNA LENGTH
=1.5
 LOAD POSITION
=1.
 FEED POSITION
=0.
 ANTENNA RADIUS
=.03
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=1.,0.,0.
 FEED VOLTAGE (REAL,IMAG)
=0.,0.
 6  LOAD IMPEDANCE (REAL,IMAG)
=50.,0.
```

```
****  ANTENNA NUMBER  3  ****
 ANTENNA LENGTH
=1.2
 LOAD POSITION
=.8
 FEED POSITION
=0.
 ANTENNA RADIUS
=.03
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=0.,1.2,.3
 FEED VOLTAGE (REAL,IMAG)
=0,0
 LOAD IMPEDANCE (REAL,IMAG)
=72.,0.
+++ RADIATION PATTERN +++
 VERTICAL PATTERN ?
=YES
 PHI (DEGREES)
=90.
 PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=10.
 HORIZONTAL PATTERN ?
=YES
 THETA (DEGREES)
=90.
 PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=10.


DIM= M  GP= N  AUTO= Y  FREQ=  125.00  NR=  3
ANT# =      1        2        3
L    =   1.000    1.500    1.200
LP   =   0.       1.000    0.800
FP   =   0.500    0.       0.
R    = 0.02000 0.03000 0.03000
X    =   0.       1.000    0.
Y    =   0.       0.       1.200
Z    =   0.       0.       0.300
RE V =   1.000    0.       0.
IM V =   0.       0.       0.
RE LD=     0.      50.0     72.0
IM LD=     0.       0.       0.
VER PAT=  Y
PHI   =  90.0  PLOT INC=  10.00
HOR PAT=  Y
THETA=  90.0  PLOT INC=  10.00


+++  14 X 14 IS THE MIN DIM FOR C1, C2 +++
+++  19 K IS THE MIN MEMORY NEEDED +++

*REMOVE  01
*OLD USAIN1
READY
```

```
*ASCBCD *;USAIN1
LABELS?
TAB CHARACTERS AND SETTING?
*SYSTEM CARD
OLD OR NEW-OLD USA
READY
*50
*500:DIMENSION C1(14,14),C2(14,14)
*5000$:LIMITS:5,19K
*LISTS 50,500,5000

500:DIMENSION C1(14,14),C2(14,14)
5000$:LIMITS:5,19K

READY

*RUN
  SNUMB # 7915T
CARD FORMAT,DISPOSITION ?
NORM
*JSTS 7915T
7915T-01 TOO BIG


*JSTS 7915T
7915T     JOB NOT ACCESSIBLE
IF LAST JOB SUBMITTED, STATUS WAS:
NORMAL TERMINATION

*BCDASC USAOUT1;*
LINE NUMBERS?
TAB CHARACTERS AND SETTING?
*LIST


 VERTICAL PATTERN

 PHI=   90.0

 EMAX=    0.588 GAIN=   1.527 GAIN(DB)=   1.84

 THETA     NMAG      NMAG(DB)
   0.      0.       -1000.00
  10.      0.1658     -15.61
  20.      0.3625      -8.81
  30.      0.5646      -4.97
  40.      0.7417      -2.60
  50.      0.8717      -1.19
  60.      0.9499      -0.45
  70.      0.9875      -0.11
  80.      1.0000       0.
  90.      0.9950      -0.04
 100.      0.9701      -0.26
 110.      0.9209      -0.72
 120.      0.8483      -1.43
 130.      0.7568      -2.42
 140.      0.6495      -3.75
 150.      0.5238      -5.62
 160.      0.3737      -8.55
 170.      0.1969     -14.12
 180.      0.0000   -1000.00
```

HORIZONTAL PATTERN

THETA= 90.0

EMAX= 0.760 GAIN= 2.553 GAIN(DB)= 4.07

PHI	NMAG	NMAG(DB)
0.	0.6146	-4.23
10.	0.6752	-3.41
20.	0.6888	-3.24
30.	0.6586	-3.63
40.	0.6044	-4.37
50.	0.5593	-5.05
60.	0.5569	-5.08
70.	0.6057	-4.35
80.	0.6852	-3.28
90.	0.7696	-2.27
100.	0.8440	-1.47
110.	0.9049	-0.87
120.	0.9528	-0.42
130.	0.9862	-0.12
140.	1.0000	0.
150.	0.9884	-0.10
160.	0.9482	-0.46
170.	0.8803	-1.11
180.	0.7912	-2.03
190.	0.6968	-3.14
200.	0.6257	-4.07
210.	0.6089	-4.31
220.	0.6522	-3.71
230.	0.7273	-2.77
240.	0.7975	-1.96
250.	0.8358	-1.56
260.	0.8275	-1.65
270.	0.7696	-2.27
280.	0.6706	-3.47
290.	0.5493	-5.20
300.	0.4320	-7.29
310.	0.3458	-9.22
320.	0.3123	-10.11
330.	0.3401	-9.37
340.	0.4183	-7.57
350.	0.5203	-5.68
360.	0.6146	-4.23

READY

*

Explanation of Example 3

1. Each antenna is divided in a certain number of segments over which the current is assumed constant. When the answer to AUTO SPEC # SEGS? is YES, the computer uses 15 segments per wavelength for the fed antennas and between 6 to 10 per wavelength for the others depending on how far they are from the fed antenna. If the answer is NO, then the actual number of segments for each antenna has to be specified by the user.
2. When there is no lead in the antenna, enter Ø here.
3. The maximum radius permissible is .1λ, thus the error message.
4. This indicates that this is the fed antenna. Other antennas can also be fed simultaneously in this version of the program. Therefore, the radiation pattern of an array of antennas can be calculated.
5. As this antenna has no load, enter Ø.,Ø. here. If there was a lead, then the real and imaginary parts of the load impedance (in ohms) should be entered here.
6. This is the real and imaginary parts of the load in ohms.

NOTE: As a reference, this run took a total of 0.0030 hours, out of which .0016 hours were used for compilation.

4.4 EXAMPLE 4 - This example illustrates the use of the communication range contour program option.

```
*SYST FORT
OLD OR NEW-NEW
READY
*RUN HS $USAIN1 "01"
+++++ ENTER ANTENNA PARAMETERS +++++

 DIMENSIONS IN METERS OR INCHES ?
=M
 GROUND PLANE ?
=N
 SIMPLE PROG ?
=Y
 COUPLING COEFFICIENTS ?
=N
 NUMBER OF ANTENNAS
=1
****  ANTENNA NUMBER  1  ****
 ANTENNA TYPE ? (1097, 197, 1181 OR 1000)
=197
 ANTENNA POSITION X,Y,Z ON THE PLATFORM
=0.,0.,0.
+++ RADIATION PATTERN +++
 VERTICAL PATTERN ?
=Y
 PHI (DEGREES)
=0.
 PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)
=10.
 HORIZONTAL PATTERN ?
=N
1  COMMUNICATION RANGE CONTOUR ?
=Y
2  RECEIVER SENSITIVITY (DBM)
=-80.
 GROUND TRANSMITTER POWER (WATT)
=10.

+++++ ENTER SITE PARAMETERS +++++

 GROUND ELEVATION IN FEET
=6546.
 TRANSIT ELEVATION IN FEET
=6568.
 ANTENNA ELEVATION IN FEET
=6586.
3  ANTENNA OFFSET FROM TRANSIT ?
=Y
```

```
  ENTER DISTANCE TO ANTENNA IN FEET
=0.
4 BEARING TO ANTENNA IN DEG AND MIN (DD.MM)
=0.0
5 USE STANDARD ALTITUDES ?
=N
  NUMBER OF ALTITUDES TO BE CALCULATED (1-6)
=6
6 DESIRED ALTITUDES IN FEET
=1000.,5000.,10000.,15000.,20000.,35000.


  GROUND  ELEV =  6546.0 FT
  TRANSIT ELEV =  6568.0 FT
  ANTENNA ELEV =  6586.0 FT
7 DIST TO ANT (FT)  =     0.
  BEAR TO ANT(DD.MM)=     0.
  AIRCRAFT ALT'S ARE IN FT AGL.
  ALT'S=  1000.0  5000.0 10000.0 15000.0 20000.0 35000.0


  NUMBER OF RUNS
=1
**** RUN #  1 ****
  FREQUENCY (MHZ)
=320.
  FED ANTENNA (#)
=1


DIM= M  GP= N  SIMP= Y  COUPL= N  NR=  1
ANT# =     1
TYPE =     197
X    =   0.
Y    =   0.
Z    =   0.
VER PAT=  Y
PHI  =   0.   PLOT INC=  10.00
HOR PAT=  N
COM RNG=  Y
REC SEN (DBM)=  -80.0 GROUND TPW (WATT)=  10.0


RUN#     FREQ(MHZ)  ANT FED(#)
  1       320.00        1


+++   7 X  7 IS THE MIN DIM FOR C1, C2 +++
+++  19 K IS THE MIN MEMORY NEEDED +++

*REMOVE  01
*OLD USAIN1
READY
*ASCBCD *;USAIN1
LABELS?
TAB CHARACTERS AND SETTING?
```

```
*SYST CARD
OLD OR NEW-OLD USA
READY
*50
*500        DIMENSION C1(7,7),C2(7,7)
*5000$:LIMITS:5,19K
*RUN
  SNUMB # 6849T
CARD FORMAT,DISPOSITION ?
NORM
*JSTS 6849T
6849T-01 WAIT-ALOC


*JSTS 6849T
6849T    JOB NOT ACCESSIBLE
IF LAST JOB SUBMITTED, STATUS WAS:
NORMAL TERMINATION

*BCDASC USAOUT1;*
LINE NUMBERS?
TAB CHARACTERS AND SETTING?
*LIST


 *** ANT# (FED)=  1  FREQ (MHZ)= 320.00 ***


 RECEIVER SENSITIVITY (DBM)= -80.0
 TRANSMITTER POWER (WATT)  =  10.0


 VERTICAL PATTERN

 PHI=     0.

 EMAX=  24.090 GAIN=  1.934 GAIN(DB)=  2.87

 THETA     NMAG      NMAG(DB)
   0.     0.0000  -1000.00
  10.     0.1622    -15.80
  20.     0.3214     -9.86
  30.     0.4739     -6.49
  40.     0.6149     -4.22
  50.     0.7392     -2.63
  60.     0.8419     -1.50
  70.     0.9197     -0.73
  80.     0.9715     -0.25
  90.     0.9980     -0.02
 100.     1.0000      0.
 110.     0.9769     -0.20
 120.     0.9261     -0.67
 130.     0.8445     -1.47
 140.     0.7295     -2.74
 150.     0.5819     -4.70
 160.     0.4057     -7.84
 170.     0.2084    -13.62
 180.     0.0000  -1000.00
```

9 COMMUNICATION RANGE CONTOUR

ALT(FT)	1000.0	5000.0	10000.0	15000.0	20000.0	35000.0
PHI(DEG)		RANGE(NM)				
0.	6.2	29.2	53.5	55.7	55.7	55.4
6.50	5.3	25.5	47.7	55.7	55.6	55.4
10.50	5.7	27.1	50.1	55.7	55.6	55.4
20.00	5.9	28.0	51.7	55.7	55.7	55.4
30.00	8.5	37.6	55.8	55.8	55.7	55.5
31.32	5.4	25.9	48.3	55.7	55.6	55.4
35.37	5.2	25.1	46.9	55.7	55.6	55.4
40.00	6.2	29.1	53.4	55.7	55.7	55.4
50.00	6.2	29.1	53.4	55.7	55.7	55.4
60.00	5.9	27.8	51.3	55.7	55.7	55.4
65.20	4.7	23.0	43.4	55.7	55.6	55.4
70.00	6.2	29.1	53.4	55.7	55.7	55.4
75.67	6.0	28.3	52.1	55.7	55.7	55.4
85.00	7.9	35.6	55.8	55.7	55.7	55.5
90.00	6.9	32.0	55.8	55.7	55.7	55.5
116.00	13.7	52.0	55.8	55.8	55.7	55.5
123.33	16.6	55.9	55.8	55.8	55.8	55.5
148.00	45.8	55.9	55.9	55.8	55.8	55.6
155.00	30.1	55.9	55.9	55.8	55.8	55.6
159.15	25.5	55.9	55.9	55.8	55.8	55.6
159.75	39.8	55.9	55.9	55.8	55.8	55.6
162.00	55.9	55.9	55.9	55.9	55.8	55.6
163.07	41.9	55.9	55.9	55.8	55.8	55.6
163.78	55.9	55.9	55.9	55.9	55.8	55.6
166.50	55.9	55.9	55.9	55.9	55.8	55.6
171.95	9.2	39.9	55.8	55.8	55.7	55.5
173.00	6.6	30.9	55.8	55.7	55.7	55.5
173.73	5.1	24.7	46.3	55.7	55.6	55.4
174.12	5.4	25.8	48.0	55.7	55.6	55.4
175.30	4.6	22.5	42.6	55.7	55.6	55.4
176.95	5.5	26.4	49.1	55.7	55.6	55.4
177.22	4.9	23.7	44.7	55.7	55.6	55.4
177.50	5.1	24.5	46.0	55.7	55.6	55.4
178.33	4.7	22.8	43.2	55.7	55.6	55.4
179.23	5.9	27.9	51.4	55.7	55.7	55.4
179.68	5.4	26.0	48.4	55.7	55.6	55.4
180.27	5.7	27.1	50.3	55.7	55.6	55.4
180.57	5.6	26.7	49.5	55.7	55.6	55.4
182.12	5.2	25.1	47.0	55.7	55.6	55.4
182.38	5.4	25.8	48.0	55.7	55.6	55.4
182.67	5.2	25.1	47.0	55.7	55.6	55.4
183.50	5.6	26.7	49.5	55.7	55.6	55.4
184.02	4.9	23.9	45.0	55.7	55.6	55.4
184.82	4.5	22.2	42.1	55.7	55.6	55.4
186.50	4.1	20.4	38.9	55.6	55.6	55.4
187.92	4.3	21.1	40.2	55.6	55.6	55.4
191.35	2.9	14.8	28.9	42.3	55.1	55.3
192.90	3.4	17.1	33.2	48.3	55.5	55.3
199.08	2.6	13.0	25.5	37.5	49.1	55.2
200.28	2.5	12.7	24.9	36.7	48.1	55.2
203.78	2.3	11.8	23.3	34.5	45.2	55.2
205.73	3.0	15.2	29.6	43.3	55.5	55.3
206.13	3.1	15.4	30.0	43.9	55.5	55.3
206.73	2.9	14.4	28.2	41.3	53.9	55.3
207.32	2.9	14.8	28.9	42.3	55.1	55.3

208.37	3.0	15.2	29.6	43.3	55.5	55.3
219.18	1.7	8.9	17.7	26.3	34.8	55.0
221.42	1.9	9.8	19.5	28.9	38.2	55.0
222.43	2.0	10.3	20.5	30.3	40.0	55.1
222.72	2.0	10.2	20.2	29.9	39.4	55.1
225.00	2.1	10.8	21.3	31.5	41.5	55.1
226.20	2.0	10.3	20.3	30.1	39.7	55.1
227.50	2.1	10.7	21.2	31.3	41.2	55.1
228.22	2.0	10.4	20.6	30.6	40.2	55.1
235.12	1.7	8.9	17.8	26.4	34.9	55.0
235.12	1.7	8.9	17.8	26.4	34.9	55.0
235.80	1.8	9.1	18.2	27.0	35.7	55.0
238.23	1.7	8.7	17.2	25.6	33.9	55.0
239.85	1.7	8.9	17.7	26.3	34.8	55.0
240.67	1.6	8.2	16.4	24.4	32.3	54.9
244.10	1.5	7.8	15.4	23.0	30.5	52.3
244.77	1.6	8.1	16.1	24.0	31.7	54.3
246.33	1.9	9.9	19.7	29.2	38.5	55.1
254.47	2.6	13.2	25.9	38.1	49.9	55.2
254.47	2.6	13.2	25.9	38.1	49.9	55.2
254.60	2.5	12.5	24.6	36.3	47.5	55.2
257.18	2.0	10.4	20.6	30.5	40.2	55.1
267.00	2.1	10.5	20.9	30.9	40.7	55.1
271.00	1.7	8.5	17.0	25.3	33.4	54.9
272.77	1.8	9.5	18.8	27.9	36.8	55.0
275.00	2.1	10.5	20.8	30.8	40.6	55.1
275.43	2.1	10.7	21.3	31.5	41.4	55.1
276.00	2.0	10.2	20.1	29.9	39.4	55.1
279.00	2.1	10.5	20.9	30.9	40.7	55.1
288.30	2.7	13.5	26.6	39.0	51.0	55.2
289.08	2.5	12.9	25.3	37.2	48.8	55.2
294.85	3.4	16.9	32.7	47.6	55.5	55.3
295.83	3.3	16.5	32.0	46.6	55.5	55.3
296.67	3.5	17.6	34.0	49.3	55.5	55.3
302.10	3.9	19.3	37.1	53.5	55.6	55.4
303.40	4.0	19.7	37.8	54.4	55.6	55.4
303.40	4.0	19.7	37.8	54.4	55.6	55.4
306.78	3.3	16.6	32.2	46.8	55.5	55.3
309.97	4.3	21.4	40.7	55.6	55.6	55.4
311.67	5.6	26.6	49.3	55.7	55.6	55.4
312.87	5.4	26.0	48.5	55.7	55.6	55.4
312.87	5.4	26.0	48.5	55.7	55.6	55.4
317.07	6.6	30.6	55.7	55.7	55.7	55.5
317.58	6.1	28.9	53.0	55.7	55.7	55.4
318.95	6.3	29.7	54.3	55.7	55.7	55.5
320.10	7.7	34.7	55.8	55.7	55.7	55.5
320.30	8.7	38.2	55.8	55.8	55.7	55.5
320.50	8.2	36.4	55.8	55.7	55.7	55.5
321.03	8.5	37.4	55.8	55.7	55.7	55.5
321.70	8.1	36.2	55.8	55.7	55.7	55.5
322.38	9.3	40.0	55.8	55.8	55.7	55.5
327.00	11.2	45.8	55.8	55.8	55.7	55.5
334.53	9.6	41.0	55.8	55.8	55.7	55.5
334.53	9.6	41.0	55.8	55.8	55.7	55.5
336.05	8.4	37.3	55.8	55.7	55.7	55.5
336.05	8.4	37.3	55.8	55.7	55.7	55.5
336.62	7.8	35.0	55.8	55.7	55.7	55.5
338.35	8.4	37.3	55.8	55.7	55.7	55.5
341.00	8.2	36.5	55.8	55.7	55.7	55.5
350.00	7.4	33.8	55.8	55.7	55.7	55.5
350.00	7.4	33.8	55.8	55.7	55.7	55.5

Explanation of Example 4

1. A request for computation of communication range is made.
2. The program does not include the coaxial cable losses and other losses within the receiver and transmitter. If known, they should be subtracted from the actual receiver sensitivity.
3. If the answer is YES, the next two questions are asked. If the answer is NO, they are skipped.
4. The bearing is measured from the north, clockwise, and is read in degrees and minutes as DDD.MM. Ex: $1.20 \equiv 1^{o}\ 20'$.
5. If the answer is NO, the next two questions are asked. If it is YES, they are skipped and the six standard altitudes of 1,000; 5,000; 10,000; 15,000; 20,000; and 35,000 feet above ground level (AGL) are assumed.
6. This is a print out of site parameters which was just read in the computer for the user's verification.
7. These statements modify the program arrays so it can be run with the smallest core possible. If the user wants to change the name DATAFILE to any name XXX... (maximum of 8 characters) the following should be typed 5025$:PRMFL:03,R/W,R,BLA00001/XXX...
9. This is the communication range contour output.
   "Line of Sight Coverage" data of Air Force Academy, Colorado Springs, are stored in the file DATAFILE.

NOTE: Data in the file DATAFILE have to be stored in the following way in each azimuth direction:

```
ZZ,ELANG,DIST,RNG(1),...,RNG(6)
 .   .    .    .     .    .
 .   .    .    .     .    .
 .   .    .    .     .    .
```

where ZZ = the azimuth angle in radians.

ELANG = the angle in radians between the screen top and the ground.

DIST = the distance between the transit and the screen.

RNG = up to six line of sight ranges in nautical miles.

As a reference, this run took a total of 0.0112 hours, out of which 0.0016 hours were used for compilation.

5. Program Limitations

The primary limitations of the program as listed in the Appendix are shown below.

a) Maximum number of runs. 10

b) Maximum number of antennas in the GENERAL PROGRAM 90

c) Maximum number of antennas in the SIMPLE PROGRAM 20

Maximum number of sub-antennas to represent antennas in the SIMPLE PROGRAM 90

Number of sub-antennas used to represent each antenna in the SIMPLE PROGRAM

AT 1181 - 1
AT 1097 - 5
AT 1000 - 1
AT 197 - 26

d) Maximum number of segments to represent the current on all antennas 200

e) Number of segments used to represent each antenna in the SIMPLE PROGRAM:

$f > 200$ MHz (UHF)

with mutual coupling calculations AT 197 - 7 if fed
51 if fed
AT 1097 - 29
AT 1181 - 16

without mutual coupling calculations AT 197 - 7 if fed
39 if not fed
AT 1097 - 29 if fed
20 if not fed
AT 1181 - 12

$f \leq 200$ MHz (VHF)

with mutual coupling calculations AT 197 - 39
AT 1097 - 21
AT 1181 - 12

without mutual coupling calculations AT 197 - 26
AT 1097 - 13
AT 1181 - 12 if fed
7 if not fed

The maximum number of the segments per wavelength used for the AT 1000 are nine in UHF and twelve in VHF.

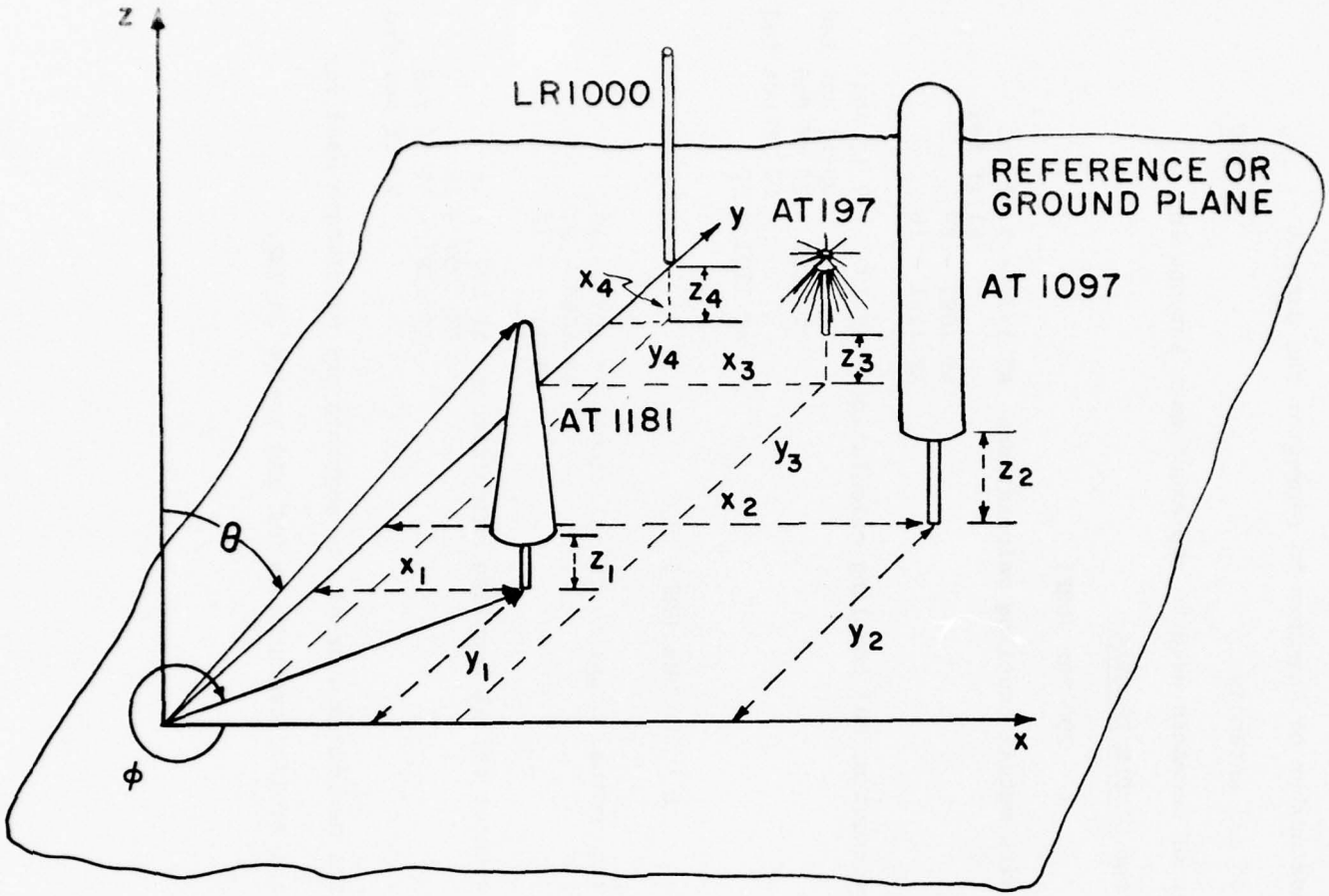


Figure 1 - Geometry and Parameters of the Simplified Program

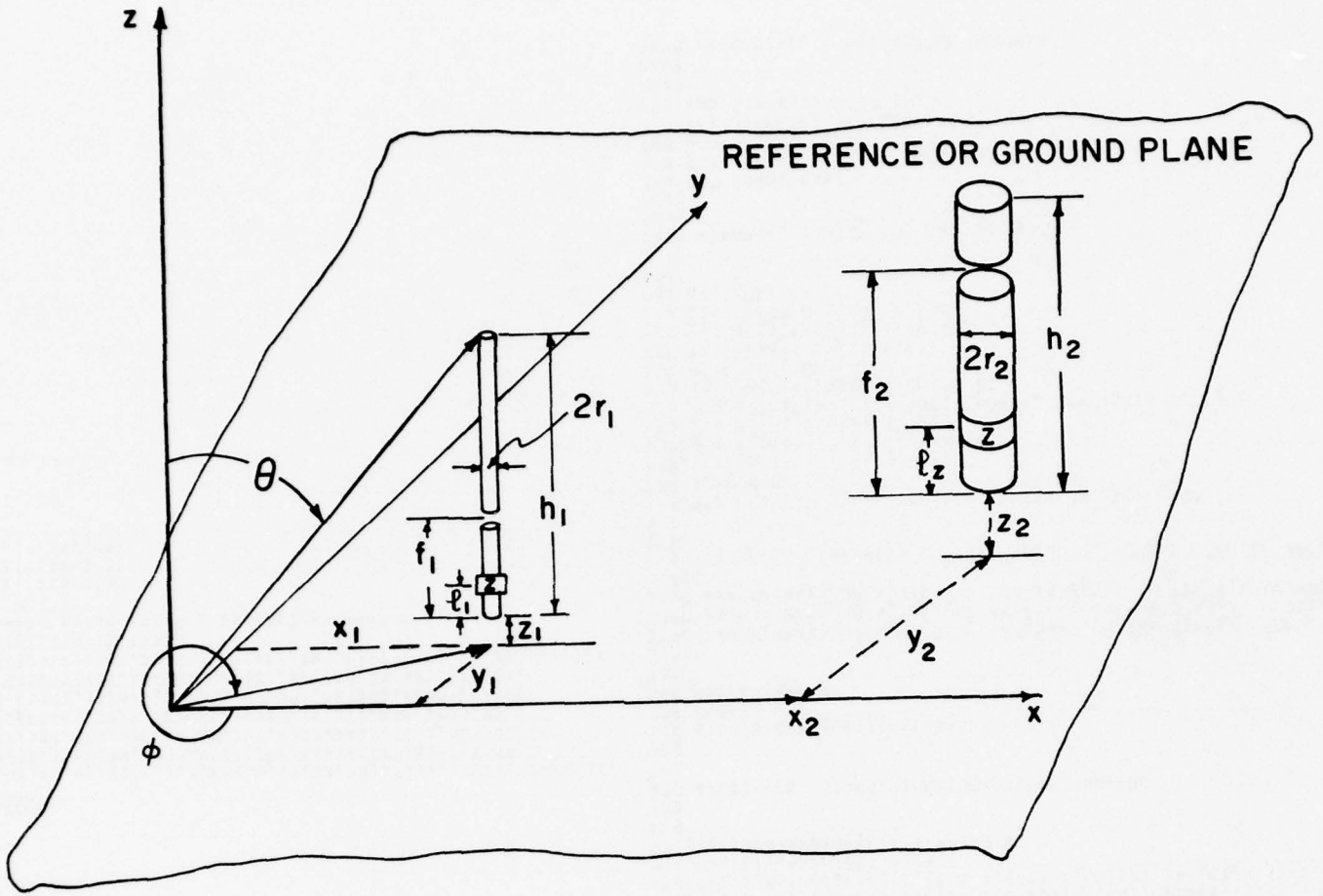


Figure 2 - Geometry and Parameters of the General Program

APPENDIX A

COMPUTER PROGRAMS

PROGRAM LINKMN

```
15 COMMON A,H0,H1,H3,RA,X,Y,Z,AV,BV,AZ,BZ,NS,L1,IF,IT,XX,YY,ZZ,IZ,
208FR,IV,IIM,GP,SIMP,NN,AUTO,KW,CL,NB,AINT,AINP,APHI,ATHE
258,H4,H5,IFP,IFT,IRG,DBM,ISIMP,ICL,IALP,IALT,IRGE,IAUTO,IGP
308,SITE(13),ALT(6),GREL,TRANEL,ANTEL,NA,DTA,BTA,APIN,FA
35 DIMENSION A(90),H0(90),H1(90),H3(90),RA(90),X(90),Y(90),
408Z(90),AV(90),BV(90),AZ(90),BZ(90),NS(90),L1(90),IF(90),
458IT(20),XX(20),YY(20),ZZ(20),IZ(40),FR(10),IV(10),H4(20),H5(20)
508,RNG(6),STDALT(6),FA(40)
115 PRINT:"+++++ ENTER ANTENNA PARAMETERS +++++"
118 PRINT:"  "
130 CALL LINK("LINK1")
140 CALL LINK("LINK2")
150 CALL LINK("LINK3")
160 STOP;END
```

PROGRAM LINKM1

```
10 SUBROUTINE SUBA
15 COMMON A,H0,H1,H3,RA,X,Y,Z,AV,BV,AZ,BZ,NS,L1,IF,IT,XX,YY,ZZ,IZ,
208FR,IV,IIM,GP,SIMP,NN,AUTO,KW,CL,NB,AINT,AINP,APHI,ATHE
258,H4,H5,IFP,IFT,IRG,DBM,ISIMP,ICL,IALP,IALT,IRGE,IAUTO,IGP
308,SITE(13),ALT(6),GREL,TRANEL,ANTEL,NA,DTA,BTA,APIN,FA
35 DIMENSION A(90),H0(90),H1(90),H3(90),RA(90),X(90),Y(90),
408Z(90),AV(90),BV(90),AZ(90),BZ(90),NS(90),L1(90),IF(90),
458IT(20),XX(20),YY(20),ZZ(20),IZ(40),FR(10),IV(10),H4(20),H5(20)
508,RNG(6),STDALT(6),FA(40)
90 IY=11953782816;IN=14773878 8
95C
92C
93C ***IY=YES, IN=NO, IIN=INCHES, IME=METERS
94C
95C
100 IIN=98062991 8;IME=1034317 88
103 ABW=0.
104 MX1=20;MX2=9
105C
106C
107C ***MX1=MAXIMUM NUMBER OF ANTENNAS IN THE SIMPLE PROGRAM
108C ***MX2=MAXIMUM NUMBER OF ANTENNAS IN THE GENERAL PROGRAM
109C ***MX2=MAXIMUM NUMBER OF SUB-ANTENNAS IN THE SIMPLE PROGRAM
112C
116C ***ENTER DIMENSION UNITS, GROUND PLANE AND TYPE OF PROGRAM
118C
119C
120 510 PRINT:" DIMENSIONS IN METERS OR INCHES ?"
130 READ 515,IIM
140 IF(IIM-IIN) 102,1 6,102
150 102 IF(IIM-IME) 1 4,106,104
160 104 PRINT 5 2;GO TO 51
170 502 FORMAT(" ..... INPUT ERROR, TRY AGAIN ?;;;;")
180 106 PRINT:" GROUND PLANE ?"
190 READ 515,IGP
200 IF(IGP-IY) 112,116,112
210 112 IF(IGP-IN) 114,517,114
220 114 PRINT 5 2;GO TO 106
230 116 GP=1,
233C
234C
235C ***GP=1, : WITH THE GROUND PLANE
236C
237C
240 515 FORMAT(A1)
250 517 PRINT:" SIMPLE PROG ?"
260 READ 515,ISIMP
270 IF(ISIMP-IY) 124,122,124
280 122 SIMP=1.;GO TO 3
283C
284C
285C ***SIMP=1, : THE SIMPLE PROGRAM
```

```
286C
287C
290 124 IF(ISIMP-IN) 126,1 ,126
300 126 PRINT 5 2;GO TO 517
303C
304C
305C ***ENTER ANTENNA DIMENSION AND LOCATION
306C
307C
310 1  PRINT!" FREQUENCY (MHZ)":READ:FR(1)
312 IF(FR(1).LE. .) PRINT 5 2
314 IF(FR(1).LE. .) GO TO 1
320 6 5 PRINT:" NUMBER OF ANTENNAS ";READ:NN
330 IF(NN.GT.0.AND.NN.LE.MX2) GO TO 520
332 IF(NN.LE.0) PRINT 5 2;IF(NN.LE. ) GO TO 605
340 PRINT 625;GO TO 6 5
350 520 PRINT:" AUTO SPEC #SEGS ?"
360 READ 515,IAUTO
370 IF(IAUTO-IY) 132,136,132
380 132 IF(IAUTO-IN) 134,138,134
390 134 PRINT 5 2;GO TO 52
400 136 AUTO=1.
403C
404C
405C ***AUTO=1, : WITH AUTO SPEC #SEGS
406C
407C
410 138 DO 285 I=1,NN
420 PRINT 274,I
430 274 FORMAT(" **** ANTENNA NUMBER",I3," ****")
440 IF(IAUTO.EQ.IY) GO TO 2
450 3 PRINT:" NUMBER OF SEGMENTS PER WAVE-LENGTH "
460 READ;A(I)
465 IF(A(I).LE. .) PRINT 5 2;IF(A(I).LE.0.) GO TO 3
470 2 PRINT:" ANTENNA LENGTH"
480 READ;H0(I)
485 IF(H0(I).LE. .) PRINT 5 2;IF(H0(I).LE.0.) GO TO 2
490 610 PRINT:" LOAD POSITION"
500 READ;H1(I)
510 IF(H1(I).GE. ..AND.H1(I).LT.H (I)) GO TO 620
520 PRINT 502;GO TO 61
530 620 PRINT:" FEED POSITION"
540 READ;H3(I)
550 IF(H3(I).GE. ..AND.H3(I).LT.H (I)) GO TO 622
560 PRINT 502;GO TO 62
570 622 PRINT:" ANTENNA RADIUS"
580 READ;RA(I)
585 IF(RA(I).LE. .) PRINT 502;IF(RA(I).LE.0.) GO TO 622
590 IF(IM-IME) 162,166,166
600 162 IF(RA(I)-124./FR(1)) 168,168,164
610 164 PRINT 5 2;GO TO 622
620 166 IF(RA(I)-31./FR(1)) 168,168,164
630 168 PRINT:" ANTENNA POSITION X,Y,Z ON THE PLATFORM"
640 READ;X(I),Y(I),Z(I)
641 IF(IIM.EQ.IIN) FA(I)=Z(I)*. 254
642 IF(IIM.EQ.IME) FA(I)=Z(I)
644 IF(GP.LT. .5.OR.Z(I).GE. .) GO TO 67
645 PRINT 502;GO TO 168
650 67 PRINT!" FEED VOLTAGE (REAL,IMAG)"
660 READ;AV(I),BV(I)
670 PRINT:" LOAD IMPEDANCE (REAL,IMAG) "
680 READ;AZ(I),BZ(I)
690 ABW=ABW+AV(I)**2+BV(I)**2
700 285 CONTINUE
710 IF(ABW-1.E-8) 56,56,310
720 56 PRINT 573
730 573 FORMAT(" **<F>**  << NO ANTENNAS ARE FED >>")
740 DO 57 I=1,NN
750 PRINT 274,I
760 PRINT:" FEED VOLTAGE (REAL,IMAG) "
770 57 READ:AV(I),BV(I)
780 GO TO 310
783C
784C
785C ***ENTER COUPLING COEFFICIENT SPECIFICATION
786C
787C
790 3 0 PRINT:" COUPLING COEFFICIENTS ?"
795 CL=0.
800 READ 515,ICL
810 IF(ICL-IY) 172,176,172
820 172 IF(ICL-IN) 174,650,174
830 174 PRINT 5 2;GO TO 330
840 176 CL=1.
841C
842C
843C ***CL=1, : WITH COUPLING COEFFICIENTS
844C
845C ***ENTER ANTENNA TYPE AND LOCATION
846C
847C
850 650 PRINT:" NUMBER OF ANTENNAS"
860 READ;NB
862 IF(NB.LE.0) PRINT 5 2;IF(NB.LE. ) GO TO 650
864 IF(CL.GT. .5.AND.NB.EQ.1) PRINT 7
865 IF(CL.GT. .5.AND.NB.EQ.1) GO TO 30
866 7 FORMAT(" **<<F>>**  << # OF ANT. GREATER THAN ONE (COUPLING
867& COEF.) >>")
870 IF(NB.GT.MX1) PRINT 625
880 625 FORMAT(" **<F>**  << TOO MANY ANTENNAS >>")
890 IF(NB.GT.MX1) GO TO 650
900 DO 295 I=1,NB
910 PRINT 274,I
920 530 PRINT:" ANTENNA TYPE ? (1 97, 197, 1181 OR 1000)"
```

```
930 READ;IT(I)
935 IF(NB.EQ.1.AND.IT(I).EQ.1000) PRINT 502
936 IF(NB.EQ.1.AND.IT(I).EQ.1000) GO TO 650
940 IF(IT(I)-1097) 182,586,182
950 182 IF(IT(I)-1181) 184,586,184
960 184 IF(IT(I)-197) 200,586,200
970 200 IF(IT(I)-1000) 202,186,202
980 186 PRINT:" LENGTH";READ:H4(I)
985 IF(H4(I).LE.0.) PRINT 502;IF(H4(I).LE.0.) GO TO 186
990 4 PRINT:" DIAMETER";READ:H5(I)
995 IF(H5(I).LE.0.) PRINT 502;IF(H5(I).LE.0.) GO TO 4
1000 GO TO 586
1010 202 PRINT 502;GO TO 530
1020 586 PRINT;" ANTENNA POSITION X,Y,Z ON THE PLATFORM"
1021 READ:XX(I),YY(I),ZZ(I)
1024 IF(GP.LT..5.OR.ZZ(I).GE.0.) GO TO 69
1026 PRINT 502;GO TO 586
1027 69 IF(IIM.EQ.IIN) FA(I)=ZZ(I)*.0254
1028 IF(IIM.EQ.IME) FA(I)=ZZ(I)
1030 N9=1
1040 IF(IT(I).EQ.1097) N9=5
1050 IF(IT(I).EQ.197) N9=26
1060 NN=NN+N9
1070 295 CONTINUE
1073C
1074C
1075C ***NN=NUMBER OF SUB-ANTENNAS IN THE SIMPLE PROGRAM
1076C
1077C
1080 IF(NN.GT.MX2) PRINT 625
1090 IF(NN.GT.MX2) STOP
1093C
1094C
1095C ***RADIATION PATTERN
1096C
1097C
1100 310 PRINT;"+++ RADIATION PATTERN +++"
1103C
1104C
1105C ***ENTER VERTICAL PATTERN SPECIFICATION
1106C
1107C
1110 550 PRINT;" VERTICAL PATTERN ?"
1120 READ 515,IALP
1130 IF(IALP-IY) 232,236,232
1140 232 IF(IALP-IN) 234,55,234
1150 234 PRINT 502;GO TO 550
1160 236 IFP=1
1170 79 PRINT:" PHI (DEGREES) ";READ;APHI
1180 580 PRINT 380;READ:AINT
1190 IF(ABS(AINT).GE..1) GO TO 55
1200 PRINT 502;GO TO 58
1203C
1204C
1205C ***ENTER HORIZONTAL PATTERN SPECIFICATION
1206C
1207C
1210 55 PRINT:" HORIZONTAL PATTERN ?"
1220 READ 515,IALT
1230 IF(IALT-IY) 242,246,242
1240 242 IF(IALT-IN) 244,65,244
1250 244 PRINT 502;GO TO 55
1260 246 IFT=1
1270 89 PRINT:" THETA (DEGREES) ";READ;ATHE
1290 590 PRINT 380;READ:AINP
1300 IF(ABS(AINP).GE..01) GO TO 65
1310 PRINT 502;GO TO 59
1311 380 FORMAT(" PLOTTING INCREMENT (NON-ZERO NUMBER) (DEGREES)")
1312 65 IF(SIMP.LT..5) GO TO 76
1313C
1314C
1316C ***ENTER COMMUNICATION RANGE CONTOUR SPECIFICATION
1319C
1320C
1321 64 PRINT:" COMMUNICATION RANGE CONTOUR ?"
1322 READ 515,IRGE
1323 IF(IRGE-IY) 70,72,70
1324 70 IF(IRGE-IN) 74,76,74
1325 74 PRINT 502;GO TO 64
1326 72 IRG=1
1327 40 PRINT:" RECEIVER SENSITIVITY (DBM)"
1328 READ:DBM
1329 IF(DBM.GE.0.) PRINT 502;IF(DBM.GE.0.) GO TO 40
1340 15 PRINT:" GROUND TRANSMITTER POWER (WATT)"
1350 READ;APIN
1360 IF(APIN.LE.0.) PRINT 502;IF(APIN.LE.0.) GO TO 15
1370 76 IF(CL.GT..5) GO TO 94
1400 IAA=IFP*IFT+IRG
1410 IF(IAA) 92,92,94
1420 92 PRINT 502;GO TO 550
1450 94 RETURN;END
```

```
PROGRAM LINKM2

    5 SUBROUTINE SUBB
   10 ASCII ANSW,ANSV
   15 COMMON A,H0,H1,H3,RA,X,Y,Z,AV,BV,AZ,BZ,NS,L1,IF,IT,XX,YY,ZZ,IZ,
  208FR,IV,IIM,GP,SIMP,NN,AUTO,KW,CL,NB,AINT,AINP,APRI,ATHE
  256,H4,H5,IFP,IFT,IRG,DBM,ISIMP,ICL,IALP,IALT,IRGE,IAUTO,IGP
  306,SITE(13),ALT(6),GREL,TRANEL,ANTEL,NA,DTA,BTA,ARIN,FA
   35 DIMENSION A(90),H0(90),H1(90),H3(90),RA(90),X(90),Y(90),
  408Z(90),AV(90),BV(90),AZ(90),BZ(90),NS(90),L1(90),IF(90),
  458IT(20),XX(20),YY(20),ZZ(20),IZ(4 ),FR(10),IV(10),H4(20),H5(20)
  506,RNG(6),STDALT(6),FA(40)
  170 DATA RNG/6*.1/
  180 DATA STDALT/1000.,5000.,10000.,15000.,20000.,35000./
  182C
  183C
  185C **STDALT=STANDARD AIRPLANE ALTITUDES IN FEET
  186C
  187C
  190 CDTR=3.1415927/180.
  210 MX3=10
  215C
  216C
  215C **MX3=MAXIMUM NUMBER OF RUNS
  218C
  217C
  220 IF(IRG.EQ.0) GO TO 94
  224C
  225C
  226C **ENTER SITE PARAMETER FOR COMMUNICATION RANGE CONTOUR
  227C
  228C
  229 PRINT:"  "
  230 PRINT:"***** ENTER SITE PARAMETERS *****"
  240 PRINT !"  "
  250 PRINT:" GROUND ELEVATION IN FEET"
  260 READ!GREL
  330 PRINT:" TRANSIT ELEVATION IN FEET"
  335 READ!TRANEL
  370 PRINT:" ANTENNA ELEVATION IN FEET"
  380 READ ! ANTEL
  400 45 PRINT!" ANTENNA OFFSET FROM TRANSIT ?"
  410 READIANSV
  415 IF(ANSV.EQ."N") GO TO 60
  420 IF(ANSV.NE."Y".AND.ANSV.NE."N") PRINT 502
  430 IF(ANSV.NE."Y".AND.ANSV.NE."N") GO TO 45
  440 70 PRINT!" ENTER DISTANCE TO ANTENNA IN FEET"
  450 READIDTA
  455 IF(DTA.LT.0.) PRINT 502!IF(DTA.LT.0.) GO TO 70
  460 PRINT:" BEARING TO ANTENNA IN DEG AND MIN (DD.MM)"
  470 READ!BEAR
  480 DEG=INT(BEAR)
  490 BTA=(DEG+(BEAR-DEG)*76.)*CDTR
  730 60 PRINT! " USE STANDARD ALTITUDES ?"
  740 READ : ANSW
  750 IF(ANSW .EQ. "Y")GO TO 20
  754 IF(ANSW.NE."Y".AND.ANSW.NE."N") PRINT 502
  754 IF(ANSW.NE."Y".AND.ANSW.NE."N") GO TO 60
  760 24 PRINT : " NUMBER OF ALTITUDES TO BE CALCULATED (1-6)"
  770 READ : NA
  775 IF(NA.LT.1.OR.NA.GT.6) PRINT 502
  780 IF(NA .LT. 1 .OR. NA .GT. 6)GO TO 24
  790 PRINT:" DESIRED ALTITUDES IN FEET"
  800 READ : (ALT(I), I = 1,NA)
  839 GO TO 900
  840 20 NA=6
  850 DO 26 I = 1,NA
  860 ALT(I) = STDALT(I)
  870 26 CONTINUE
  879C
  880C **PRINT OUT THE INPUT DATA OF THE COMMUNICATION RANGE
  889C
  950 900 PRINT 915,GREL,TRANEL,ANTEL
  960 IF(ANSV.EQ."Y") PRINT 916,DTA,BEAR
  970 916 FORMAT(" DIST TO ANT (FT)  =",F8.1,/,
  975&" BEAR TO ANT(DD.MM)=",F9.2,/)
  990 PRINT:"AIRCRAFT ALT'S ARE IN FT AGL."
 1010 PRINT 917,(ALT(I),I=1,NA)
 1030 245 CONTINUE
 1780 915 FORMAT(//,"0GROUND  ELEV =",F8.1," FT",/,
 1710&" TRANSIT ELEV =",F8.1," FT",/,
 1720&" ANTENNA ELEV =",F8.1," FT",/)
 1730 914 FORMAT(" ALT'S=",6F8.1,/)
 1740       DTA=DTA*.3048
 1750 ANTEL=ANTEL*.3048
 1760 TRANEL=TRANEL*.3048
 1765 GREL=GREL*.3048
 1810 502 FORMAT(" ...,.. INPUT ERROR, TRY AGAIN ,.,.,")
 1815 94 IF(SIMP.LT..5) GO TO 350
 1820C
 1821C
 1822C **ENTER MULTIPLE RUN SPECIFICATION
 1823C
 1824C
 1825 PRINT!"  "
 1850 192 PRINT!" NUMBER OF RUNS"
 1860 READ!KW
 1865 IF(KW.LE.0) GO TO 194
 1870 IF(KW-MX3) 196,196,194
 1880 194 PRINT 502;GO TO 192
 1890 196 DO 228 J=1,KW
 1900 IV(J)=0
 1910 PRINT 140,J
 1920 140 FORMAT(" **** RUN #",I3," ****")
 1930 223 PRINT!" FREQUENCY (MHZ)";READ!FR(J)
 1935 IF(FR(J).LE.0.) PRINT 502!IF(FR(J).LE.0.) GO TO 223
```

```
1920 FRE=FR(J)
1930 628 PRINT," FED ANTENNA (#)";:READ:IV(J)
1940 IW=IV(J)
1950 IF(IW) 224,224,222
1960 222 IF(IW-NB) 225,225,224
1970 224 PRINT 5,2:GO TO 628
1980 225 IF(IT(IW).EQ.1.00) GO TO 224
1990 IF(FRE-200.) 226,226,227
2000 226 IF(IT(IW)-197) 210,229,210
2010 210 IF(IT(IW)-197) 228,229,228
2020 227 IF(IT(IW)-1181) 228,229,228
2030 229 PRINT 5,2:GO TO 223
2040 228 CONTINUE
2050 GO TO 400
2053C
2054C
2055C ***PRINT OUT THE INPUT DATA OF THE GENERAL PROGRAM
2056C
2057C
2060 350 PRINT 42,IIN,IGP,IAUTO,FR(1),NN
2070 NQ=NN
2080 IF(NN.GT.8) NQ=8
2090 PRINT 555,(I,I=1,NQ)
2100 555 FORMAT(" ANT# =",I6,7I8)
2110 IF(AUTO.GT..5) GO TO 4
2120 PRINT 14,(A(I),I=1,NN)
2130 4 PRINT 16,(H0(I),I=1,NN)
2140 PRINT 18,(H1(I),I=1,NN)
2150 PRINT 22,(H3(I),I=1,NN)
2160 PRINT 62,(RA(I),I=1,NN)
2170 PRINT 64,(X(I),I=1,NN)
2180 PRINT 28,(Y(I),I=1,NN)
2190 PRINT 30,(Z(I),I=1,NN)
2200 PRINT 32,(AV(I),I=1,NN)
2210 PRINT 34,(BV(I),I=1,NN)
2220 PRINT 36,(AZ(I),I=1,NN)
2230 PRINT 38,(BZ(I),I=1,NN)
2240 KW=1
2250 GO TO 450
2253C
2254C
2255C ***PRINT OUT THE INPUT DATA OF THE SIMPLE PROGRAM
2256C
2257C
2260 400 PRINT 12,IIN,IGP,ISIMP,ICL,NB
2270 NQ=NB
2280 IF(NB.GT.8) NQ=8
2290 PRINT 555,(I,I=1,NQ)
2300 PRINT 44,(IT(I),I=1,NB)
2310 PRINT 64,(XX(I),I=1,NB)
2320 PRINT 28,(YY(I),I=1,NB)
2330 PRINT 30,(ZZ(I),I=1,NB)
2340 DO 156 I=1,NB
2350 IF(H4(I).GT.1.E-10) II8=1
2360 156 CONTINUE
2370 IF(II8.NE.0) PRINT 152,(H4(I),I=1,NB)
2380 IF(II8.NE.0) PRINT 154,(H5(I),I=1,NB)
2390 152 FORMAT(" L     =",8F8.3/(7X,8F8.3))
2400 154 FORMAT(" D     =",8F8.3/(7X,8F8.3))
2410 39 FORMAT(" VER PAT=",2X,A1)
2420 450 PRINT 39,IALP
2430 IF(IFP.EQ.0) GO TO 453
2440 PRINT 66,APHI,AINT
2450 453 PRINT 558,IALT
2460 IF(IFT.EQ.0) GO TO 78
2470 558 FORMAT(" HOR PAT=",2X,A1)
2480 PRINT 41,ATHE,AINP
2490 78 IF(SIMP.GT..5) PRINT 80,IRGE
2500 80 FORMAT(" COM RNG=",2X,A1)
2510 IF(IRG.EQ.0) GO TO 660
2520 PRINT 100,DBM,APIN
2530 100 FORMAT(" REC SEN (DBM)=",F7.1," GROUND PPW (WATT)=",F6.1)
2540 41 FORMAT(" THETA=",F6.1,1X," PLOT INC=",F7.2)
2550 12 FORMAT(///" DIM=",1X,A1,1X," GP=",1X,A1,1X," SIMP=",1X,A1,1X,
2560&" COUPLE",1X,A1,1X," NR=",I3)
2570 14 FORMAT(" #SEGS=",8F8.2/(7X,8F8.2))
2580 16 FORMAT(" L     =",8F8.3/(7X,8F8.3))
2590 18 FORMAT(" LP    =",8F8.3/(7X,8F8.3))
2600 22 FORMAT(" FP    =",8F8.3/(7X,8F8.3))
2610 62 FORMAT(" R     =",8F8.5/(7X,8F8.5))
2620 64 FORMAT(" X     =",8F8.3/(7X,8F8.3))
2630 28 FORMAT(" Y     =",8F8.3/(7X,8F8.3))
2640 30 FORMAT(" Z     =",8F8.3/(7X,8F8.3))
2650 32 FORMAT(" RE V  =",8F8.3/(7X,8F8.3))
2660 34 FORMAT(" IM V  =",8F8.3/(7X,8F8.3))
2670 36 FORMAT(" RE _D=",8F8.1/(7X,8F8.1))
2680 38 FORMAT(" IM _D=",8F8.1/(7X,8F8.1))
2690 42 FORMAT(///" DIM=",1X,A1,1X," GP=",1X,A1,1X," AUTO=",1X,A1,1X,
2700&" FREQ=",F8.2,1X," NR=",I3)
2710 44 FORMAT(" TYPE  =",8I8/(7X,8I8))
2720 66 FORMAT(" PHI   =",F6.1,1X," PLOT INC=",F7.2)
2730 660 RETURN:END
```

PROGRAM LINKM3

```
      SUBROUTINE SUBC
      COMMON A,H0,H1,H3,RA,X,Y,Z,AV,BV,AZ,BZ,NS,L1,IF,IT,XX,YY,ZZ,IZ,
     &FR,IV,IIM,GP,SIMP,NN,AUTO,KW,CL,NB,AINT,AINP,APHI,ATHE
     &,H4,H5,IFP,IFT,IRG,DBM,ISIMP,ICL,IALP,IALT,IRGE,IAUTO,IGP
     &,SITE(13),ALT(6),GREL,TRANEL,ANTEL,NA,DTA,BTA,APIN,FA
      DIMENSION A(90),H0(90),H1(90),H3(90),RA(90),X(90),Y(90),
     &Z(90),AV(90),BV(90),AZ(90),BZ(90),NS(90),L1(90),IF(90),
     &IT(20),XX(20),YY(20),ZZ(20),IZ(4),FR(10),IV(10),H4(20),H5(20)
     &,RNG(6),STDALT(6),FA(40)
      MAXS=200;IME=1034317 080
C
C
C***IME=METERS
C***MAXS=MAXIMUM NUMBER OF SEGMENTS
C
C
  250 FORMAT(3I4,I2,2F3.0)
  252 FORMAT(9F7.3)
  254 FORMAT(8F8.5)
  256 FORMAT(6E11.3)
  258 FORMAT(3I3,4F7.2)
  260 FORMAT(I5,15I4)
      AIN=1.
      IF(IIM.NE.IME) AIN=.0254
      MX=4
      IF(SIMP.GT..5) PRINT 10
   10 FORMAT(//* RUN#     FREQ(MHZ)  ANT FED(#)")
      DO 456 L=1,KW
      LXY=0
      IJ=0
      FRE=FR(L)
      IF(SIMP.LT..5) GO TO 450
C
C
C**CALCULATE THE NECESARY PARAMETERS FOR THE SIMPLE PROGRAM
C
C
      PRINT 30,L,FR(L),IV(L)
   30 FORMAT(I4,5X,F8.2,3X,I6)
      DO 350 I=1,NB
      NM=I
      IF(IT(I).EQ.197) NM=5
      IF(IT(I).EQ.197) NM=26
      DO 340 J=1,NM
      AJ=J;IJ=IJ+1
      AV(IJ)=0.;BV(IJ)=0.
      AZ(IJ)=90.;BZ(IJ)=0.
      X(IJ)=XX(I)*AIN;Y(IJ)=YY(I)*AIN
      IF(IT(I).EQ.100) GO TO 132
      IF(CL-1.) 142,145,145
  142 IF(FRE-200.) 143,143,144
  143 A(IJ)=8.5*250./FRE;GO TO 148
  144 A(IJ)=13.3*250./FRE;GO TO 148
  145 IF(FRE-200.) 144,144,146
  146 A(IJ)=14.8*300./FRE
  148 IF(IT(I).NE.197) GO TO 158
      AZ(IJ)=0.
      IF(J.EQ.1) GO TO 82
      IF(J.EQ.2) GO TO 84
      IF(J.LE.14) GO TO 86
      Z(IJ)=.51+ZZ(I)*AIN
      A(IJ)=11.8*300./FRE
      H0(IJ)=.17;RA(IJ)=.0035
      GO TO 340
   82 A(IJ)=4.2*300./FRE
      IF(CL.GT..5.OR.FRE.GT.200.) A(IJ)=6.25*300./FRE
      H0(IJ)=.48;RA(IJ)=.0175;Z(IJ)=ZZ(I)*AIN
      GO TO 340
   84 AZ(IJ)=90.;H0(IJ)=.03;RA(IJ)=.002
      Z(IJ)=.48+ZZ(I)*AIN
      IF(FRE.LE.200.) GO TO 340
      IF(IV(L).NE.1) GO TO 340
      AV(IJ)=1.;AZ(IJ)=0.
      LXY=1
      GO TO 340
   86 Z(IJ)=.48+ZZ(I)*AIN
      H0(IJ)=.45;RA(IJ)=.0045
      A(IJ)=6.66*300./FRE
      IF(FRE.LE.200.) GO TO 46
      IF(IV(L).EQ.1.OR.CL.GT..5) A(IJ)=8.89*300./FRE
      GO TO 340
   46 IF(CL.LT..5) A(IJ)=4.44*300./FRE
      GO TO 340
  158 IF(NM.EQ.1) GO TO 32
      RA(IJ)=.0754;H0(IJ)=.54;H1(IJ)=.27;H3(IJ)=.27
      IF(J.EQ.5) GO TO 37
      GO TO 330
  370 RA(IJ)=.0191;H0(IJ)=.279;AZ(IJ)=0.;H1(IJ)=0.;H3(IJ)=0.
      A(IJ)=7.4*300./FRE
      GO TO 330
  320 RA(IJ)=.0628;H0(IJ)=1.1684;H1(IJ)=.8001;H3(IJ)=.8001
  330 Z(IJ)=ZZ(I)*AIN+(AJ-1.)*(H0(IJ)+.1461)
      IF(J.EQ.5) Z(IJ)=ZZ(I)*AIN+4.*.754+3.*.1461
      IF(IV(L).NE.1.OR.J.EQ.5) GO TO 34
C
C
C** CALCULATE ANTENNA AT1097 FEED VOLTAGES AV,BV
C
C
      AAA=J-1
      BETA=2.*3.141593*.04166*FRE/(.6951*300.)
      ABC=BETA*AAA
      IF(J.EQ.4) ABC=.0378094*FRE
      AV(IJ)=COS(ABC);BV(IJ)=-SIN(ABC);AZ(IJ)=0.
```

```
820 A(IJ)=13.3*25[illegible]./FRE
830 IF(FRE.GT.2[illegible].) A(IJ)=14.8*3[illegible]./FRE
840 GO TO 340
850 132 AZ(IJ)= .;H1(IJ)=0;;Z(IJ)=ZZ(I)*AIN
860 H[illegible](IJ)=H4(I)*AIN;RA(IJ)=H5(I)*AIN/2.
870 A(IJ)=4.*30[illegible]./FRE
880 IF(FRE.GT.2[illegible].) A(IJ)=6.*3[illegible]./FRE
890 340 CONTINUE
900 350 CONTINUE
910 450 KK=0.
920 IF(L.GT.1) GO TO 66
930 IF(SIMP.GT..5)GO TO 18[illegible]
940 DO 50 I=1,NN
950 IF(IIM.EQ.IME) GO TO 560
960 H0(I)=.0254*H0(I)
970 H1(I)=.0254*H1(I)
980 H3(I)=.0254*H3(I)
990 RA(I)=.0254*RA(I)
1000 X(I)=.0254*X(I)
1010 Y(I)=.0254*Y(I)
1020 Z(I)=.0254*Z(I)
1030 560 ABV=AV(I)**2+BV(I)**2
1040 IF(ABV.LT.1.E-20) GO TO 5[illegible]
1050 KK=KK+1
1060 KF=I
1070 50 CONTINUE
1080 180 II2=0
1090 DO 182 I=1,NN
1100 IF(BZ(I)*BZ(I).GT.1.E-10) II2=1
1110 182 CONTINUE
1113C
1114C
1115C **WRITE THE OUTPUT IN FILE " 1"
1116C
1117C
1120 WRITE(01,25[illegible]) N3,NN,KW,II2,GP,CL
1130 WRITE(01,252) (A[illegible](I),I=1,NN)
1140 WRITE(01,254) (RA(I),I=1,NN)
1150 WRITE(01,252) (X(I),I=1,NN)
1160 WRITE(01,252) (Y(I),I=1,NN)
1170 WRITE(01,252) (Z(I),I=1,NN)
1180 IF(II2.NE.[illegible]) WRITE(01,256) (BZ(I),I=1,NN)
1186 42 FORMAT(4F8.1,F9.6,2F6.1)
1190 WRITE(01,258) IFP,IFT,IRG,ATHE,APHI,AINT,AINP
1192 IF(IRG.EQ.1) WRITE(01,42) GREL,TRANEL,ANTEL,DTA,BTA,DBM,ARIN
1195 IF(IRG.EQ.1) WRITE(01,252) (FA(I),I=1,NB)
1196 IF(IRG.EQ.1) WRITE(01,35) NA,(ALT(I),I=1,NA)
1198 35 FORMAT(I3,(6F8.1))
1200 IF(NB.NE.0) WRITE( 1,260) (IT(I),I=1,NB)
1210 660 WAVE=3[illegible]./FRE
1220 MM=0;II=0
1230 DO 210 I=1,NN
1240 CC=1
1250 IF(GP.GT..5.AND.Z(I).LT.1.E-10) CC=0.
1260 IF(AUTO,LT..5) GO TO 1[illegible]
1270 IF(KK,EQ.1) GO TO 6[illegible]
1280 GO TO 7[illegible]
1290 60 DD=(X(KF)-X(I))**2+(Y(KF)-Y(I))**2
1300 DS=SQRT(DD)
1310 BB=10
1320 A(I)=BB*.8
1330 IF(DS/WAVE.GT.2.5) A(1)=BB*.6
1340 IF(DS/WAVE.LT.1.[illegible]) A(I)=BB
1350 IF(I.EQ.KF) A(I)=BB*1.5
1360 GO TO 100
1370 70 A(I)=8
1380 IF(AV(I)*AV(I).GT.1.E-1[illegible].OR.BV(I)*BV(I).GT.1.E-10) A(I)=15
1390 100 DEL=WAVE/A(I)
1400 IF(SIMP.GT..5) GO TO 12[illegible]
1410 IF(DEL.LT.2.*RA(I).AND.RA(I).LE..02) GO TO 11[illegible]
1420 IF(DEL.LT..7*RA(I)) GO TO 11
1430 GO TO 120
1440 110 AA=WAVE/RA(I)/2.
1450 IF(RA(I).GT..02) AA=3.*AA
1460 GO TO 14[illegible]
1470 120 A0=H0(I)/DEL-.CC
1480 A1=H1(I)/DEL+1.-CC
1490 A3=H3(I)/DEL+1.-CC
1500 I0=A0;I1=A1;I3=A3;B0=I0;B1=I1;B3=I3
1510 NS(I)=I0+1;J1=I1+1;J3=I3+1
1520 IF(A0.LT.B0+.5) NS(I)=I0
1530 IF(I0.EQ.0) NS(I)=1
1540 IF(A1.LT.B1+.5.OR.J1.GT.NS(I)) J1=I1
1550 IF(I1.EQ.0) J1=1
1560 IF(A3.LT.B3+.5.OR.J3.GT.NS(I)) J3=I3
1570 IF(I3.EQ.0) J3=1
1580 IF(J1.GT.NS(I)) J1=NS(I)
1590 IF(J3.GT.NS(I)) J3=NS(I)
1600 IF(I.EQ.1) GO TO 13[illegible]
1610 MM=MM+NS(I-1)
1620 130 L1(I)=MM+J1
1630 IF(I)=MM+J3
1640 IF(IF(I).EQ.L1(I)) GO TO 16[illegible]
1650 GO TO 210
1660 140 PRINT 15[illegible],I,AA
1670 150 FORMAT(" **<F>**  << THE",I3," TH A(I) MUST BE LESS THAN",
1680 &F5.1," >>")
1690 GO TO 20[illegible]
1700 160 ABV=AV(I)*AV(I)+BV(I)*BV(I)
1710 ABZ1=AZ(I)*AZ(I)+BZ(I)*BZ(I)
1720 IF(ABV.LT.1.E-20) GO TO 21[illegible]
1730 IF(ABZ1.LT.1.1-2 ) GO TO 21[illegible]
1740 PRINT 19[illegible],I
1750 190 FORMAT(" **<F>**  << THE",I3," TH LOAD FEED ARE TOO CLOSE
```

```
1760& >>")
1770 200 II=II+1
1780 210 CONTINUE
1790 IF(II.NE.0) GO TO 500
1800 MM=MM+NS(NN)
1810 IF(NB.EQ.0) GO TO 192
1815 IF(LXV.EQ.0) GO TO 192
1820 MM=0
1822 NR=0
1824 K=0
1828 DO 195 I=1,NB
1832 NX=1
1836 KX=0
1840 IF(IT(I).EQ.1097) NX=5
1844 IF(IT(I).EQ.197) NX=26
1848 IF(NX.EQ.26.AND.IV(L).EQ.I) KX=1
1856 DO 195 J=1,NX
1860 K=K+1
1862 IF(KX.EQ.1.AND.J.GT.3.AND.J.NE.15) GO TO 193
1864 MM=MM+NS(K)
1866 GO TO 194
1870 193 NR=NR+NS(K)
1874 194 L1(K)=L1(K)-NR
1878 IF(K)=IF(K)-NR
1900 195 CONTINUE
1910 192 IF(MM.LE.MAXS) GO TO 22
1920 PRINT 215,MM
1930 215 FORMAT(" **<F>** << NO. OF SEGMENTS", I5," ARE TOO BIG >>")
1940 GO TO 500
1950 220 K=0
1960 IF(CL.LT..5) GO TO 600
1970 NZ=0
1980 DO 410 I=1,NB
1990 NM=1
2000 IF(IT(I).EQ.1097) NM=5
2010 IF(IT(I).EQ.197) NM=26
2020 DO 408 J=1,NM
2030 K=K+1
2040 IF(J.EQ.5) GO TO 408
2050 IF(IT(I).EQ.10 0) GO TO 408
2060 IF(NM.EQ.26.AND.J.NE.2) GO TO 408
2070 NZ=NZ+1
2080 IZ(NZ)=IF(K)
2090 408 CONTINUE
2100 410 CONTINUE
2110 600 IF(MM.GT.MX) MX=MM
2120 II4=0;II6=
2130 DO 184 I=1,NN
2140 IF(BV(I)+BV(I).GT.1.E-10) II4=1
2150 IF(AZ(I).GT.1.E-10) II6=1
2160 184 CONTINUE
2170 WRITE(01,40) MM,NZ,IV(L),II4,II6,FR(L)
2180 WRITE(01,252) (AV(I),I=1,NN)
2190 IF(II4.NE.0) WRITE(01,252) (BV(I),I=1,NN)
2200 IF(II6.NE.0) WRITE(01,256) (AZ(I),I=1,NN)
2210 WRITE(01,260) (NS(I),I=1,NN)
2220 WRITE(01,260) (L1(I),I=1,NN)
2230 WRITE(01,260) (IF(I),I=1,NN)
2240 IF(CL.GT..5) WRITE(01,260) (IZ(I),I=1,NZ)
2250 40 FORMAT(3I4,2I3,F7.2)
2260 456 CONTINUE
2263C
2264C
2265C ***PRINT DIMENSION FOR C1,C2
2266C
2267C
2270 PRINT 261,MX,MX
2280 261 FORMAT(//" +++",I4," X",I3," IS THE MIN DIM FOR C1, C2 +++")
2290 AM=MX;AMAX=AM+AM+2./100.;MAX1=AMAX;BMAX=MAX1
2300 IF(BMAX+.5.LT.AMAX) MAX1=MAX1+1
2310 MAXK=MAX1+1
2320 IF(MAXK.LE.48) MAXK=MAX1+19
2323C
2324C
2325C ***PRINT CORE SPECIFICATION FOR THE PROGRAM USA
2326C
2327C
2330 PRINT 262,MAXK
2340 262 FORMAT(" +++",I4," K IS THE MIN MEMORY NEEDED +++")
2350 500 RETURN;END
```

```
      PROGRAM USA
10$       IDENT   BLA00001,PERINI-KH,956700160409,KH
20$       USERID  BLA00001$DREF
30$       OPTION  FORTRAN
50$       MSG1    1, THIS PROGRAM USES 75K MEMORY
51$       FORTRAN NDECK,NLSTIN
66C
67C
68C       *** CALCULATE THE RADIATION PATTERN
69C
70C
71        SUBROUTINE PATT(APHI,ATHE,IW,AIT,AINT,AMAX,PIN,ALT,IY,FA)
72        COMMON X,Y,Z,X1,Y1,Z1,HO,NS,FP,AK,GP,NN,NB,AC,BC,IT,AZ,NA,RNG
73       1 ,GREL,TRANEL,ANTEL,DTA,BTA,DBM,IFP,IFT,IRG
74        DIMENSION X(90),Y(90),Z(90),HO(90),NS(90),AC(200),RNG(6),FA(40)
75       1 ,X1(90),Y1(90),Z1(90),IT(20),AZ(361),BC(200),ALT(6),ATH(6)
76        BK=AK*FP/3.E8
77        R2=2.*3437.75*6080.
78        R3=R2*.5*.3048*4./3.
79        FX=1.E-7*AK*FP
80        J1=0
81 70     J1=J1+1
82        IF(IFP.EQ.1.AND.IY.EQ.1) GO TO 31
83        IF(IFT.EQ.1.AND.IY.EQ.2) GO TO 34
84        IF(IRG.EQ.1) GO TO 38
85 31     IF(J1.NE.1) ATHE=ATHE+AINT
86        GO TO 36
87 34     IF(J1.NE.1) APHI=APHI+AINT
88 36     PHI=APHI/57.29578
89        THE=ATHE/57.29578
90        GO TO 39
91C
92C
93C       *** READ THE LINE OF SIGHT DATA FROM DATAFILE
94C
95C
97 38     READ(3'J1) ZZ,ELANG,DIST,RNG
98        IF(ZZ.GT.9998./57.29578) GO TO 100
99        AX=DTA*SIN(BTA)
100        AY=DTA*COS(BTA)
101       SX=DIST*SIN(ZZ)*.3048
102       SY=DIST*COS(ZZ)*.3048
103       ATS=SQRT((SX-AX)**2+(SY-AY)**2)
104       PHI=ATAN2((SX-AX),(SY-AY))
105       IF(PHI.LT.0.) PHI=PHI+2.*3.1415927
106       HSCRN=DIST*.3048*SIN(ELANG+DIST/R2)/COS(ELANG+DIST/R2)+TRANEL
107       TTH=ATAN2(HSCRN-ANTEL-FA(IW),ATS)-ATS*.75/(R2*.3048)
108       THE=3.141593*.5-TTH
109 39     M=0
110       CP=COS(PHI)
111       CT=COS(THE)
112       SP=-SIN(PHI)
113       ST=SIN(THE)
114       AE=0.
115       BE=0.
116       NX=NB
117       IF(NB.EQ.0) NX=NN
118       I=0
119       DO 20 KS=1,NX
120       NK=1
121       MK=0
122       IF(NB.EQ.0) GO TO 3
123       IF(IT(KS).EQ.107) NK=5
124       IF(IT(KS).EQ.197) NK=26
125       IF(NK.EQ.26.AND.KS.EQ.IW) MK=1
126#3      DO 20 KQ=1,NK
127       MW=0
128       I=I+1
129       IF(NK.NE.26) GO TO 56
130       IF(KQ-14) 50,50,54
131#50     IF(KQ.EQ.2) GO TO 56
132       MW=1
133       GO TO 56
134#54    MW=3
135#56    IF(I-1) 10,10,45
136#45    IF(MK.EQ.0) GO TO 5
137       IF(KQ.GT.3.AND.KQ.NE.15) GO TO 10
138#5     JJ=I-1
139       M=M+NS(JJ)
140#10    NSI=NS(I)
141       NG=1
142       IF(GP) 12,14,12
143#12     IF(Z(I)) 14,13,14
144#13     NG=0
145#14     AN=NSI+NG
146       IF(KQ.GT.14) NG=0
147       IF(NK.EQ.26.AND.KQ.NE.2) AN=AN-1.
148       DO 20 J=1,NSI
149       A1=J-2+NG
150       N=M+J
151       AA=GP
152       IF(J-1) 17,15,17
153#15     IF(Z(I)) 17,16,17
154#16     AA=0.
155#17     AP=1.+AA
156       AM=1.-AA
157       DO 20 L=1,3
158       AX=L
159       KK=1
160       A=A1+AX*.5
161       IF(L.NE.2) GO TO 32
162       A2=1.
163       IF(MW.EQ.1.AND.J.EQ.NSI) KK=2
164       IF(MW.EQ.3.AND.J.EQ.1) KK=2
165#32    BB=KK
```

```
      DO 20 K=1,KK
      IF(J.NE.1.AND.L.EQ.1) GO TO 35
      T1=X1(I)-X(I)
      T2=Y1(I)-Y(I)
      T3=Z1(I)-Z(I)
      DK=RO(I)/AN*.5
      IF(MW.NE.1.OR.J.NE.NSI) GO TO 60
      IF(KK.NE.2.AND.L.NE.3) GO TO 60
#58   T1=0.
      T2=0.
      T3=1.
      DK=.0075
      GO TO 65
#60   IF(MW.NE.3.OR.J.NE.1) GO TO 65
      IF(KK.EQ.1.AND.L.NE.3) GO TO 58
#65   RQ=SQRT(T1*T1+T2*T2+T3*T3)
      DA=DK*A*2./RQ
      PX=X(I)+DA*T1
      PY=Y(I)+DA*T2
      PZ=Z(I)+DA*T3
      SS=DK*.5*3.141593
      IF(L.NE.2) A2=.5
      DD=A2*DK/BB
      DT=(T1*CT*CP+T2*CT*SP)/RQ
      DS=-T3*ST/RQ
      PS=BK*(PX*CP+PY*SP)*ST
      P3=COS(PS)
      P4=SIN(PS)
      PQ=BK*CT*PZ
      P5=SIN(PQ)
      P6=COS(PQ)
#35   P1=P3*AC(N)-P4*BC(N)
      P2=P3*BC(N)+P4*AC(N)
      QS=P5*(DT*AP+DS*AM)
      QC=P6*(DT*AM+DS*AP)
      AE=AE-(P1*QC-P2*QS)*DD
      BE=BE-(P1*QS+P2*QC)*DD
#20   CONTINUE
      BB=AE*AE+BE*BE
      AZ(J1)=FX*SQRT(BB)
      IF(IRG.EQ.1.AND.IY.EQ.3) GO TO 72
      IF(AZ(J1).GT.AMAX) AMAX=AZ(J1)
      IF(IFP.EQ.1.AND.IY.EQ.1.AND.ATHE.LE.AIT+.001-AINT) GO TO 70
      IF(IFT.EQ.1.AND.IY.EQ.2.AND.APHI.LE.AIT+.001-AINT) GO TO 70
      GMAX=AMAX*AMAX/PIN/30.
      GDB=10.*ALOG10(GMAX)
      WRITE(2,280) AMAX,GMAX,GDB
      WRITE(6,280) AMAX,GMAX,GDB
#280  FORMAT(/' EMAX=',F8.3,' GAIN=',F7.3,' GAIN(DB)=',F6.2)
      GO TO 100
 72   RRR=AZ(J1)/(BK*SQRT(120.*DBM))
      DO 80 I=1,NA
      UU=RNG(I)*1852./R3
      VV=ALT(I)*.3048+GREL+R3
      WW=ANTEL+FA(IW)+R3
      RR=SQRT(VV**2+WW**2-2.*WW*VV*COS(UU))
      ALP=1.
      IF(RRR.GT.VV-WW) ALP=(WW**2+VV**2-RRR**2)/(2.*WW*VV)
      PPP=ARCOS(ALP)
      IF(RRR.LT.RR) RNG(I)=R3*PPP/1.852.
      RG=1.E-5
      IF(RNG(I).GT.1.E-8) RG=RNG(I)*1.852.
      QQ1=(ALT(I)*.304+GREL-ANTEL-FA(IW))/RG
      QQQ=ATAN(QQ1)-RG/(R3*2.)
      IF(RR.LT.RRR) QQQ=TTH
      ATH(I)=QQQ*57.29578
 80   CONTINUE
      APHI=PHI*57.29578
      ATHE=90.-THE*57.29578
      WRITE(2,74) APHI,(RNG(I),I=1,NA)
      WRITE(6,74) APHI,(RNG(I),I=1,NA)
 74   FORMAT(F7.2,1X,6F8.1/(6F8.1))
      GO TO 70
100   RETURN
      END
$     FORTRAN NDECK,NLSTIN
      SUBROUTINE FUN(DD,DE,Y9,SUM,NDIM)
      DIMENSION Y9(13)
      SUM=0
      NDH=NDIM/2+1
      DO 10 I=2,NDIM
      HH=.5*DE
      IF(I.LE.NDH) HH=.5*DD
      SUM=SUM+HH*(Y9(I)+Y9(I-1))
10    CONTINUE
      RETURN
      END
$     FORTRAN NDECK,NLSTIN
      FUNCTION ELE(P)
      IF(P-1.) 3,5,5
#4    WRITE(6,100) P
      STOP
#100  FORMAT(10X,'ILLEGAL ARGUMENT FOR ELE, ARG=',E13.4)
#5    ELE=1.
      RETURN
#3    AM1=1.-P
      ELE=1.+AM1*(.4630151+.1077812*AM1-(.2452727+.0412496
     X *AM1)*ALOG(AM1))
      RETURN
      END
$     FORTRAN NDECK,NLSTIN
      FUNCTION ELK(P)
      IF(P-1.) 3,4,4
#4    WRITE(6,100) P
```

```
      STOP
100   FORMAT(10X,'ILLEGAL ARGUMENT FOR ELK, ARG=',E13.4)
3     AM1=1.-P
      ELK=1.386294+AM1*(.1119723+.0725296*AM1)-(.5+AM1*
     X (.1213478+.0288729*AM1))*ALOG(AM1)
      RETURN
      END
$     FORTRAN NDECK,NLSTIN
C
C
C     *** CALCULATE THE ANTENNA POSITION (X,Y,Z) AND (X1,Y1,Z1)
C
C
      SUBROUTINE PXYZ
      COMMON X,Y,Z,X1,Y1,Z1,H0,NS,FP,AK,GP,NN,NB,AC,BC,IT,AZ,NA,RNG
     1 ,GREL,TRANEL,ANTEL,DTA,BTA,DBM,IFP,IFT,IRG
      DIMENSION H0(90),X(90),Y(90),Z(90),X1(90),Y1(90),Z1(90)
     1 ,NS(90),AC(200),BC(200),IT(20),AZ(361),RNG(6)
      NX=NN
      IF(NB) 2,2,1
1     IF(NB.NE.0) READ(1,20) (IT(I),I=1,NB)
      NX=NB
      TH0=150.
      PH0=0.
      THX=TH0*.0174533
      C=COS(THX)
      SIT=SIN(THX)
      L=0
      DO 319 LS=1,NX
      NK=1
      IF(NB.EQ.0) GO TO 318
      IF(IT(LS).EQ.1097) NK=5
      IF(IT(LS).EQ.197) NK=26
318   DO 315 LQ=1,NK
      L=L+1
      ALS=LQ
      IF(NB.EQ.0) GO TO 305
      IF(IT(LS).NE.197) GO TO 305
      IF(LQ-2) 305,305,303
303   IF(LQ-14) 312,312,308
305   X1(L)=X(L)
      Y1(L)=Y(L)
      Z1(L)=Z(L)+H0(L)
      GO TO 315
308   PH1=30.*(ALS-15.)+PH0
      PHX=PH1*.0174533
      X1(L)=X(L)+H0(L)*COS(PHX)
      Y1(L)=Y(L)+H0(L)*SIN(PHX)
      Z1(L)=Z(L)
      GO TO 315
312   PH1=30.*(ALS-3.)+PH0
      PHX=PH1*.0174533
      X1(L)=X(L)
      Y1(L)=Y(L)
      Z1(L)=Z(L)
      X(L)=X1(L)+H0(L)*SIT*COS(PHX)
      Y(L)=Y1(L)+H0(L)*SIT*SIN(PHX)
      Z(L)=Z1(L)+H0(L)*C
315   CONTINUE
319   CONTINUE
20    FORMAT(I5,15I4)
      RETURN
      END
$     FORTRAN NDECK,NLSTIN
      SUBROUTINE QZP(K1,L9,II,L8,MX,MZ,KX,NP)
      COMMON X,Y,Z,X1,Y1,Z1,H0,NS,FP,AK,GP,NN,NB,AC,BC,IT,AZ,NA,RNG
     1 ,GREL,TRANEL,ANTEL,DTA,BTA,DBM,IFP,IFT,IRG
      DIMENSION X(90),Y(90),Z(90),H0(90),NS(90),AC(200),BC(200)
     1 ,X1(90),Y1(90),Z1(90),IT(20),NP(20),AZ(361),RNG(6)
      J=0
      DO 20 I=KX,K1
      J=J+NP(I)
20    CONTINUE
      MX=II-J
      MZ=0
      M1=L9+1
      M2=L9+L8
      DO 50 J=M1,M2
      MZ=MZ+NS(J)
50    CONTINUE
      RETURN
      END
$     FORTRAN NDECK,NLSTIN
C
C
C     *** CALCULATE THE NORMALIZED RADIATION PATTERN
C
C
      SUBROUTINE NPAT(AMAX,AIT,AINT)
      COMMON X,Y,Z,X1,Y1,Z1,H0,NS,FP,AK,GP,NN,NB,AC,BC,IT,AZ,NA,RNG
     1 ,GREL,TRANEL,ANTEL,DTA,BTA,DBM,IFP,IFT,IRG
      DIMENSION X(90),Y(90),Z(90),X1(90),Y1(90),Z1(90)
     1 ,H0(90),NS(90),AC(200),BC(200),AZ(361),IT(20),RNG(6)
      I=0
      ATH=-AINT
10    ATH=ATH+AINT
      I=I+1
      FM=AZ(I)/AMAX
      IF(FM.LT.1.E-5) GO TO 252
      FDB=20.*ALOG10(FM)
      GO TO 254
252   FDB=-1000.
254   WRITE(6,88) ATH,FM,FDB
      WRITE(2,88) ATH,FM,FDB
```

```
      IF(ATH.LE.AIT+.001-AINT) GO TO 10
88#   FORMAT(F5.0,F10.4,F10.2)
      RETURN
      END
$     FORTRAN MDECK,NLSTIN
$     LIMITS  ,30000,,,
C
C
C     *** MAIN PROGRAM
C
C
      COMMON X,Y,Z,X1,Y1,Z1,HO,NS,FP,AK,GP,NN,NB,AC,BC,IT,AZ,NA,RNG
     1 ,GREL,TRANEL,ANTEL,DTA,BTA,DBM,IFP,IFT,IRG
      DIMENSION C1(150,150),C2(150,150)
      DIMENSION HO(90),RA(90),X(90),Y(90),Z(90),AV(90),BV(90)
     1 ,AZ(361),L1(90),NS(90),IF(90),IZ(90),AC(200),RNG(6),FA(40),
     2 AP(5),BP(5),ZZ(5),AQ(5),BQ(5),LR(200),LT(20),C5(3,3),BC(200)
     3 ,A3(13),B3(13),C3(5,16),C4(5,16),FR(10),IV(10),C6(3,3)
     4 ,BZ(90),X1(90),Y1(90),Z1(90),S3(5),EF(4),FF(4),NP(20),ALT(6)
      CALL RANSTZ(03,9)
      N5=11
      N6=13
      AN=N5-1
      CN=N6-1
C
C
C     *** READ FILE USAIN1
C
C
      READ(1,10) NB,NN,KW,II2,GP,CL
      READ(1,12) (HO(I),I=1,NN)
      READ(1,14) (RA(I),I=1,NN)
      READ(1,12) (X(I),I=1,NN)
      READ(1,12) (Y(I),I=1,NN)
      READ(1,12) (Z(I),I=1,NN)
      DO 4 I=1,NN
4     BZ(I)=0.
      IF(II2.NE.0) READ(1,16) (BZ(I),I=1,NN)
17    FORMAT(4F8.1,F9.6,2F6.1)
      READ(1,18) IFP,IFT,IRG,ATHE,APHI,AINT,AINP
      IF(IRG.EQ.1) READ(1,17) GREL,TRANEL,ANTEL,DTA,BTA,DBM,APIN
      IF(IRG.EQ.1) READ(1,12) (FA(I),I=1,NB)
      IF(IRG.EQ.1) READ(1,15) NA,(ALT(I),I=1,NA)
      DDD=DBM
      DBM=1.E-3*10.**(DBM*.1)
15    FORMAT(I3,(6F8.1))
C
C
C     *** SPECIFY ANTENNA POSITION (X,Y,Z) AND (X1,Y1,Z1)
C
C
      CALL PXYZ
10#   FORMAT(3I4,I2,2F3.0)
12#   FORMAT(9F7.3)
14#   FORMAT(8F8.5)
16#   FORMAT(6F11.3)
18    FORMAT(3I3,4F7.2)
20#   FORMAT(I5,15I4)
3#    FORMAT(3I4,2I3,F7.2)
      DO 100 KV=1,KW
C
C
C     *** READ FILE USAIN1
C
C
      READ(1,3) MM,NZ,IV(KV),II4,II6,FR(KV)
      HX=.015
      ALAM=300./FR(KV)
      IW=IV(KV)
      DO 6 I=1,NN
      BV(I)=0.
6#    AZ(I)=0.
      READ(1,12) (AV(I),I=1,NN)
      IF(II4.NE.0) READ(1,12) (BV(I),I=1,NN)
      IF(II6.NE.0) READ(1,16) (AZ(I),I=1,NN)
      READ(1,20) (NS(I),I=1,NN)
      READ(1,20) (L1(I),I=1,NN)
      READ(1,20) (IF(I),I=1,NN)
      IF(CL.EQ.1.) READ(1,20) (IZ(I),I=1,NZ)
      IF(NB.NE.0) WRITE(2,320) IV(KV),FR(KV)
320#  FORMAT(//' *** ANT# (FED)=',I3,1X,' FREQ (MHZ)=',F7.2,' ***')
      FP=FR(KV)*1.E6
      IF(NB.NE.0) WRITE(6,320) IV(KV),FR(KV)
      IF(IRG.EQ.1) WRITE(2,305) DDD,APIN
      IF(IRG.EQ.1) WRITE(6,305) DDD,APIN
305   FORMAT(//' RECEIVER SENSITIVITY (DBM)=',F6.1/
     1 ' TRANSMITTER POWER (WATT)  =',F6.1//)
310#  A4=0.
      B5=0.
      DO 24 I=1,MM
      LR(I)=0
      DO 24 J=1,MM
      C1(I,J)=0.
24#   C2(I,J)=0.
      DO 19 I=1,5
      DO 19 J=1,16
      C3(I,J)=0.
19#   C4(I,J)=0.
      EF=0.
      EG=0.
      AK=2.*3.141593
      CW=AK*.25/CN
      EPS=1.E-9/(16.*AK)
      XMU=2.E-7*AK
```

```
990         OME=AK*FP
995         OMP=OME*EPS
1000         XK=OME/3.E8
1010         XL=XK*XK
1012C
1013C
1014C       *** CALCULATE THE GENERALIZED IMPEDANCE MATRIX C1,C2
1015C
1016C
1018        K2=2
1019        IF(GP.EQ.0.) K2=1
1020        BLO=ALOG(2.)
1022        II=0
1024        K3=0
1030        K=0
1032        NX=NB
1034        IF(NB.EQ.0) NX=NN
1040        DO 325 KS=1,NX
1041        MK=0
1042        NK=1
1043        NP(KS)=0
1044        IF(NB.EQ.0) GO TO 8
1045        IU=-1
1046        IF(IT(KS).EQ.1097) NK=5
1048        IF(IT(KS).EQ.197) NK=26
1049        IF(NK.EQ.26.AND.IW.EQ.KS) MK=1
1050#8       DO 324 KQ=1,NK
1052        K=K+1
1053        IF(MK.EQ.1.AND.KQ.GT.3.AND.KQ.NE.15) GO TO 324
1054        L=0
1056        MV=0
1080        K9=K-1
1090        KG=1
1100        IF(GP.NE.0..AND.Z(K).EQ.0.) KG=0
1110        AS=NS(K)+KG
1112        IF(NK-25) 298,290,298
1113#290    IF(KQ-2) 295,298,292
1114#292    IF(KQ-14) 295,295,294
1115#294    MV=2
1116        AS=AS-1.
1117        GO TO 298
1118#295    MV=1
1119        AS=AS-1.
1124#298    DK=HO(K)/AS
1126        NP(KS)=NP(KS)+NS(K)
1130        IF(K.EQ.1) GO TO 26
1140#182    II=II+NS(K9)
1150#26     NSK=NS(K)
1155        J=0
1156        DO 80 LS=1,NX
1157        NL=1
1158        ML=0
1160        IF(NB.EQ.0) GO TO 9
1161        IF(IT(LS).EQ.1097) NL=5
1162        IF(IT(LS).EQ.197) NL=26
1164        IF(NL.EQ.26.AND.LS.EQ.IW) ML=1
1166#9       DO 80 LQ=1,NL
1167        L=L+1
1172        L9=L-1
1190        K8=0
1192        KG=1
1195        IF(K.NE.L.OR.RA(L).LT..02*ALAM) KG=0
1197        IF(GP.NE.0..AND.Z(K).EQ.0.) KG=0
1200        LG=1
1210        IF(GP) 126,128,126
1220#126    IF(Z(L)) 128,127,128
1230#127    LG=0
1240#128    AT=NS(L)+LG
1241        MW=0
1242        IF(NL-26) 288,281,288
1243#281    IF(LQ-2) 285,288,282
1244#282    IF(LQ-14) 285,285,284
1245#284    MW=2
1246        AT=AT-1.
1247        GO TO 288
1251#285    MW=1
1253        AT=AT-1.
1257#288    DL=HO(L)*.5/AT
1258        IF(K.NE.L.OR.RA(L).LT..02*ALAM) LG=0
1266        ALP=DL*.5
1269        XKD=XK*ALP
1272        AP1=1.005*ALP
1275        AKL=AK*ALP
1278        XD=XKD*XKD
1281        AW=2.*ALP/AN
1284        IF(L9) 28,28,180
1285#180    IF(ML.EQ.0) GO TO 134
1286        IF(LQ.GT.3.AND.LQ.NE.15) GO TO 28
1287#134    J=J+NS(L9)
1290#28     NSL=NS(L)
1293        DO 460 KK=1,K2
1300        N1=1
1301        G=3-2*KK
1302        IF(KK-1) 162,146,162
1305#146    IF(NB) 148,164,148
1306#148    IF(KS-LS) 440,430,440
1307#430    IF(LS.EQ.1) GO TO 440
1308        IF(IW.EQ.0) GO TO 440
1309        IF(IW.GT.0) GO TO 460
1311        L8=26
1312        IF(IT(LS).EQ.197.AND.LS.NE.IW) GO TO 435
1313        IF(IT(LS).NE.1097) GO TO 440
1314        IF(LS.EQ.IW.AND.CL.EQ.0.) GO TO 440
1315        L8=5
```

```
1316#435   LX=LS
1317       K1=LS-1
1318       IU=0
1319       DO 438 JX=1,K1
1320       IF(L8-10) 445,445,443
1321#443   IF(JX.EQ.IW.OR.IT(JX).NE.197) GO TO 438
1322       GO TO 449
1323#445   IF(IT(JX).NE.1097.OR.(JX.EQ.IW.AND.CL.EQ.0.)) GO TO 438
1325#448   IU=IU+1
1326       KX=JX
1327#438   CONTINUE
1328       IF(IU.EQ.0) GO TO 440
1329       CALL QZP(K1,L8,II,L9,MX,MZ,KX,NP)
1335       DO 450 I=1,MZ
1336       MP=MX+I
1337       KM=II+I
1338       DO 450 JX=1,MZ
1339       MQ=MX+JX
1340       LN=II+JX
1341       C1(KM,LN)=C1(MP,MQ)
1342       C2(KM,LN)=C2(MP,MQ)
1343#450   CONTINUE
1344       GO TO 460
1345#440   IF(K9) 164,164,138
1346#138   IF(K-L) 164,139,164
1347#139   IF(NL.EQ.26.OR.IT(KS).EQ.1000) GO TO 164
1348       DO 152 K5=1,K9
1349       BR=RA(K5)-RA(K)
1350       HH=HO(K5)-HO(K)
1351       HN=NS(K5)-NS(K)
1352       RH=RR*RR+HH*HH+HN*HN
1353       IF(RH-1.E46) 150,152,152
1354#150   DO 156 K7=1,K3
1355       K8=K7
1356       IF(LR(K7)-K5) 156,154,156
1357#156   CONTINUE
1358#154   GO TO 164
1359#152   CONTINUE
1360       GO TO 164
1361#162   IF(Z(L)) 164,158,164
1362#158   M1=2
1363#164   KP=(KK-1)**2+(K-L)**2
1364       DO 455 M=1,NSK
1365       KM=II+M
1366       IF(KP) 23,22,23
1367#22    IF(NL.EQ.26) GO TO 23
1371       M1=M
1374#23    ZK=M-1+KG
1375       PZK=Z(K)+DK*ZK
1376       IF(GP.NE.0..AND.Z(K).EQ.0.) ZK=ZK-1
1377       DO 78 N=N1,NSL
1380       LN=J+N
1381       IF(IT(KS).EQ.1000) GO TO 31
1382       IF(KK-1) 31,25,31
1383#25    IF(NL.EQ.26.OR.NK.EQ.26) GO TO 32
1385       IF(L-K) 78,27,31
1386#27    IF(N1-1) 29,29,72
1387#29    IF(K9) 173,31,173
1389#173   IF(K8) 31,31,174
1390#174   CC=C3(K8,N)
1391       CD=C4(K8,N)
1392       GO TO 76
1393#32    IF(KS.NE.LS) GO TO 31
1395       IF(KK.EQ.2) GO TO 11
1398       IF(ML.EQ.1) GO TO 11
1399       IF(KQ.LE.3.AND.LQ.LE.3) GO TO 31
1400       IF(LQ.NE.3.AND.LQ.NE.15) GO TO 36
1401       IF(KQ.GT.3.AND.KQ.NE.15) GO TO 37
1402       GO TO 31
1403#36    IF(KQ.EQ.3.OR.KQ.EQ.15) GO TO 31
1404       JP=0
1405       JQ=0
1406       IF(KQ.GE.4.AND.KQ.NE.15) JP=NS(K)
1407       IF(LQ.GE.4.AND.LQ.NE.15) JQ=NS(L)
1408       GO TO 40
1409#11    IF(KQ.GT.2) GO TO 31
1410       IF(LQ.LE.3.OR.LQ.EQ.15) GO TO 31
1411       CC=C5(M,N)
1412       CD=C6(M,N)
1413       GO TO 76
1414#31    ZL1=N-1+LG
1415       CC=0.
1416       CD=0.
1419       MC=4
1422       IF(K.NE.L.OR.RA(L).LT..02*ALAM) MC=1
1425       DO 69 MN=1,MC
1427       IF(MC.EQ.1) GO TO 35
1428       IF(N-N1) 34,35,34
1434#34    IF(MN-3) 64,35,35
1437#35    AMN=MN-1
1440       ZL=ZL1+ZL1-1.5+AMN
1443       IF(MC.EQ.4) GO TO 329
1446       ZL=ZL1+.5
1447       IF(GP.NE.0..AND.Z(L).EQ.0.) ZL=ZL-1
1450       JQ=11-(KK-1)*4
1451       IF(NL.LT.6) GO TO 108
1452       IF(ML.EQ.0) JQ=7-(KK-1)*2
1453       IF(ML.EQ.0.AND.CL.EQ.0.) JQ=5
1454#108   IF(KS.NE.LS) JQ=3
1455       QJ=JQ-1
1456       KT=JQ/2+1
1458       QK=KT-1
1459       JY=1
1460       IF(N.EQ.N1.OR.JQ.EQ.3) GO TO 361
```

```
      JY=2
      A3(1)=A3(JT)
      B3(1)=B3(JT)
#361  JT=JQ
      DO 360 JJ=JY,JT
      AJ=JJ-1
      DL=HO(L)/AT
      IF(JJ.LE.KT) DD=DL/QJ
      DE=DL/QJ
      ZD=(ZL+AJ/QJ)*DL
      RQ=RA(L)
      T1=X1(L)-X(L)
      T2=Y1(L)-Y(L)
      T3=Z1(L)-Z(L)
      R1=SQRT(T1*T1+T2*T2+T3*T3)
      IF(JJ.LE.KT.OR.MW.NE.1) GO TO 363
      IF(N.NE.NSL) GO TO 363
      DL=HX
      DE=DL/QJ
      RQ=.002
      T1=0.
      T2=0.
      T3=1.
      R1=1.
      PXL=X1(L)
      PYL=Y1(L)
      PZL=Z1(L)*(AJ-QK)*DE
      GO TO 370
#363  IF(JJ.GT.KT.OR.MW.NE.2) GO TO 366
      IF(N.NE.1) GO TO 366
      DL=HX
      DD=DL/QJ
      RQ=.002
      T1=0.
      T2=0.
      T3=1.
      R1=1.
      ZD=-DL*.5+AJ*DD
#366  ZE=ZD/R1
      PXL=X(L)+ZE*T1
      PYL=Y(L)+ZE*T2
      PZL=Z(L)+ZE*T3
#370  A3(JJ)=0.
      B3(JJ)=0.
      IF(JQ.EQ.3.AND.JJ.NE.2) GO TO 360
      DO 350 JX=1,2
      AJX=JX
      U1=X1(K)-X(K)
      U2=Y1(K)-Y(K)
      U3=Z1(K)-Z(K)
      R0=SQRT(U1**2+U2**2+U3**2)
      DK=HO(K)/AS
      IF(JX-1) 352,352,355
#352  IF(MV.NE.2.OR.M.NE.1) GO TO 353
      DK=HX
      U1=0.
      U2=0.
      U3=1.
      R0=1.
      PXK=X(K)
      PYK=Y(K)
      PZK=Z(K)-DK
      GO TO 354
#353  DKR=DK*ZK/R0
      PXK=X(K)+DKR*U1
      PYK=Y(K)+DKR*U2
      PZK=Z(K)+DKR*U3
#354  DR=DK/R0
      PX1=PXK+DR*U1
      PY1=PYK+DR*U2
      PZ1=PZK+DR*U3
      GO TO 358
#355  IF(MV.NE.1.OR.M.NE.NSK) GO TO 356
      DK=HX
      U1=0.
      U2=0.
      U3=1.
      R0=1.
      PXK=X1(K)
      PYK=Y1(K)
      PZK=Z1(K)
      GO TO 357
#356  PXK=PX1
      PYK=PY1
      PZK=PZ1
#357  DR=DK/R0
      PX1=PXK+DR*U1
      PY1=PYK+DR*U2
      PZ1=PZK+DR*U3
#358  DX=XK*DK
      CS=COS(DX)
      SN=SIN(DX)
      P1=PXL-PXK
      P2=PYL-PYK
      P3=PZL*3-PZK
      P4=PXL-PX1
      P5=PYL-PY1
      P6=PZL*3-PZ1
      ZH=(P1*U1+P2*U2+P3*U3)/R0
      IF(ABS(ZH).LT.1.E-15) ZH=0.
      C=P1**2+P2**2+P3**2+R0**2
      SD=SQRT(C-ZH**2)
      DX=PXK+ZH*U1/R0
      DY=PYK+ZH*U2/R0
```

```
1737        DZ=PZK+ZH*U3/R0
1740        WX=(PXL-DX)/SD
1743        WY=(PYL-DY)/SD
1746        WZ=(PZL*G-DZ)/SD
1749        R4=SQRT(C)
1752        R5=SQRT(P4**2+P5**2+P6**2+R0**2)
1755        XR=XK*R4
1758        SR=SIN(XR)
1761        CR=COS(XR)
1764        XT=XK*R5
1767        ST=SIN(XT)
1770        CT=COS(XT)
1773        ZI=ZH-DK*(2.-AJX)
1774        IF(ABS(ZI).LT.1.E-15) ZI=0.
1776        WS=ZI*ZI
1779        IF(JX-1) 380,380,384
1782#380    WD=R5*R5
1785        WR=XT*WD
1788        E1=30.*((-SR/R4+CS*ST/R5)/SN-ZI*(ST-XT*CT)/WR)
1791        E2=30.*((-CR/R4+CS*CT/R5)/SN-ZI*(CT+XT*ST)/WR)
1794        E3=30.*((ZH*SR/R4-ZI*CS*ST/R5)/SN-(XT*WS*CI+(WD-WS)*ST
1797       1 )/WR)/SD
1800        E4=30.*((ZH*CR/R4-ZI*CS*CT/R5)/SN-((WD-WS)*CI-XT*WS*ST
1803       1 )/WR)/SD
1806        GO TO 386
1809#384    WD=R4*R4
1812        WR=XR*WD
1815        E1=30.*((-ST/R5+CS*SR/R4)/SN+ZI*(SR-XR*CR)/WR)
1818        E2=30.*((-CT/R5+CS*CR/R4)/SN+ZI*(CR+XR*SR)/WR)
1820        ZI=ZH-DK
1821        E3=30.*((-ZH*CS*SR/R4+ZI*ST/R5)/SN+(XR*WS*CR+(WD-WS)*SR
1824       1 )/WR)/SD
1827        E4=30.*((-ZH*CS*CR/R4+ZI*CT/R5)/SN+((WD-WS)*CR-XR*WS*SR
1830       1 )/WR)/SD
1833#386    EX=E3*WX+E1*U1/R0
1836        FX=E4*WX+E2*U1/R0
1839        EY=E3*WY+E1*U2/R0
1842        FY=E4*WY+E2*U2/R0
1845        EZ=E3*WZ+E1*U3/R0
1848        FZ=E4*WZ+E2*U3/R0
1851        A3(JJ)=((EX*T1+EY*T2)*G+EZ*T3)/R1+A3(JJ)
1854#350    B3(JJ)=((FX*T1+FY*T2)*G+FZ*T3)/R1+B3(JJ)
1855#360    CONTINUE
1856        IF(KS-LS) 362,364,362
1857#362    EF=A3(2)*(DD+DE)
1858        EG=B3(2)*(DD+DE)
1859        GO TO 368
1860#364    CALL FUN(DD,DE,A3,EF,JQ)
1861        CALL FUN(DD,DE,B3,EG,JQ)
1862#368    AQ(MN)=-EF
1866        BQ(MN)=-EG
1870        AM=1.

1916        GO TO 57
1919#329    PZL=P(L)+DL*ZL
1920        PL=1.
1921        IF(G) 330,335,335
1922#330    PL=-1.
1929#335    R33=DK*.5
1930        R43=DL*.5
1936        XX=X(K)-X(L)
1941        YY=Y(K)-Y(L)
1946        S3(1)=PZK-PZL*G
1947        S3(2)=S3(1)+R33+R43
1948        S3(3)=S3(1)-R33-R43
1949        S3(4)=S3(1)+R33-R43
1950        S3(5)=S3(1)-R33+R43
1960        QX=QME*XMU*DK*DL
1990        DO 60 I=1,5
1992        ZZ(I)=S3(I)
1994        C=XX**2+YY**2+ZZ(I)**2+RA(L)**2
2000        ZJ=ZZ(I)*ZZ(I)
2010        AA=C-ZJ
2020        B=SQRT(C)
2030        ABZ=ABS(ZZ(I))
2040        IF(B-10.*ALP) 42,38,38
2070#38     ACOS=COS(XK*B)/(2.*AK*B)
2080        BSIN=-SIN(XK*B)/(2.*AK*B)
2090        ZR2=ZJ/C
2095        IF(ZR2.LT.1.E-10) ZR2=0.
2100        ZR4=ZR2*ZR2
2110        DR2=ALP*ALP/C
2120        H=(-1.+3.*ZR2)/6.+(3.-30.*ZR2+35.*ZR4)/40.*DR2
2130        A2=-ZR2/6.-DR2*(1.-12.*ZR2+15.*ZR4)/40.
2133        A2=A2*1.E5
2135        XZR=1.E5*XD*ZR4/120.
2140        PSI1=1.+DR2*H+XD*(A2+XZR)*1.E-5
2150        PSI2=XKD*(H+XD*(3.*ZR2-5.*ZR4)/60.)*ALP/B
2160        GO TO 50
2290#42     C=AA*2.+ZJ
2300        B=SQRT(C)
2310        ACOS=COS(XK*B)/AK
2320        BSIN=-SIN(XK*B)/AK
2330        A0=XL*B*.5
2340        A1=(1.-XL*C*.5)/AKL
2350        A2=-XL*.5/AKL
2360        B0=XK*(-.5+XL*(C*.25+(ALP*ALP/3.+C+AA)/12.))
2370        B1=XK*B*(1.-XL*C/6.)/AKL
2380        B2=-XK*XL*B*.5/AKL
2390        DO 45 MZ=1,N5
2400        BN=MZ-1
2410        ZP=ALP*((BN+BN)/AN-1.)
2420        ZX=ZZ(I)-ZP
2430        Z3=4.*AA+ZX*ZX
2440        Z2=SQRT(Z3)
```

```
2450        P=4.*AA/Z3
2460        B3(MZ)=ELE(P)*Z2
2470        IF(ABZ-AP1) 45,45,39
2480#39     A3(MZ)=ELK(P)/Z2
2490#45     CONTINUE
2500        CALL FUN(AW,AW,B3,B5,N5)
2510        IF(ABZ-AP1) 46,46,44
2520#44     CALL FUN(AW,AW,A3,A5,N5)
2530        GO TO 48
2540#46     AI=1.
2550        IF(ABZ-1.E-5) 52,53,53
2560#52     AI=2
2570#53     DO 47 MZ=1,N6
2580        BN=MZ-1
2590        TP=AK*.25*BN/CN
2600        S=SIN(TP)
2610        Y3=ALP*ALP+AA*S*S*AI*AI
2620        Y2=ALP+SQRT(Y3)
2630        Y7=Y2/(AI*BA(L))
2640#47     A3(MZ)=ALOG(Y7)
2650        CALL FUN(CW,CW,A3,A4,N6)
2660        A5=AI*(.5*AK*BLO+2.*A4)*.5
2670#48     PSI1=A0+A1*A5+A2*B5
2680        PSI2=B0+B1*A5+B2*B5
2690#50     AP(I)=ACOS*PSI1-BSIN*PSI2
2700        BP(I)=BSIN*PSI1+ACOS*PSI2
2710#60     CONTINUE
2760#56     AQ(MN)=-OX*BP(1)+(BP(4)+BP(5)-BP(2)-BP(3))/OMP
2780        BQ(MN)=OX*AP(1)-(AP(4)+AP(5)-AP(2)-AP(3))/OMP
2790        GO TO 69
2800#64     AQ(MN)=AQ(MN+2)
2810        BQ(MN)=BQ(MN+2)
2820#68     AM=.75
2830        IF(MN-1) 55,55,54
2840#54     IF(MN-4) 57,55,55
2850#55     AM=.25
2860#57     CC=AQ(MN)*AM+CC
2865#69     CD=BQ(MN)*AM+CD
2868        IF(KK.EQ.2) GO TO 76
2871        IF(KS.NE.LS.OR.ML.EQ.0) GO TO 41
2872        IF(KQ.GT.2) GO TO 41
2873        IF(LQ.EQ.3.OR.LQ.EQ.15) GO TO 49
2875#41     IF(NL.EQ.26.OR.IT(KS).EQ.1000) GO TO 76
2880        IF(KP) 76,160,76
2890#160    IF(NB) 161,76,161
2900#161    IF(N-1) 167,166,167
2910#166    K3=K3+1
2920#167    C3(K3,N)=CC
2930        C4(K3,N)=CD
2940        LR(K3)=K
2941        GO TO 75
2942#49     C5(M,N)=CC
2943        C6(M,N)=CD
2950        GO TO 76
2951#37     I3=15
2952        IF(KQ.LT.15) I3=3
2953        I1=KM-NS(K)*(KQ-I3)
2954        J1=LN+NS(L)*(12+I3-KQ)
2955        GO TO 43
2956#40     I1=KM-JP
2957        J1=LN-JQ
2958#43     C1(KM,LN)=C1(I1,J1)
2959        C2(KM,LN)=C2(I1,J1)
2960        GO TO 78
2969#72     K1=KM-1
2970        L2=LN-1
2980        C1(KM,LN)=C1(K1,L2)
2990        C2(KM,LN)=C2(K1,L2)
3000#79     C1(LN,KM)=C1(KM,LN)
3010        C2(LN,KM)=C2(KM,LN)
3020        GO TO 78
3030#76     C1(KM,LN)=CC+C1(KM,LN)
3040        C2(KM,LN)=CD+C2(KM,LN)
3050        IF(KK.EQ.1.AND.(NL.NE.26.AND.NK.NE.26)) GO TO 79
3052#78     CONTINUE
3053#455    CONTINUE
3054#460    CONTINUE
3055#80     CONTINUE
3056#324    CONTINUE
3058#325    CONTINUE
3059C
3060C
3061C       *** ADD THE LOAD AZ,BZ
3062C
3063C
3064        DO 90 M=1,NN
3065        I=L1(M)
3066        C1(I,I)=C1(I,I)+AZ(M)
3070#90     C2(I,I)=C2(I,I)+BZ(M)
3098C
3099C
3100C       *** INVERT THE MATRIX C1,C2
3101C
3102C
3120        MY=MM
3150#98     DO 105 I=1,MY
3160#105    LR(I)=I
3170        DO 118 M=1,MY
3180        K=M
3190        DO 102 I=M,MY
3200        A1=C1(I,M)*C1(I,M)+C2(I,M)*C2(I,M)
3210        A2=C1(K,M)*C1(K,M)+C2(K,M)*C2(K,M)
3220        IF(A1-A2) 102,102,106
3230#106    K=I
```

```
3240#102   CONTINUE
3250       LS=LR(M)
3260       LR(M)=LR(K)
3270       LR(K)=LS
3280       STOR1=C1(K,M)
3290       STOR2=C2(K,M)
3300       SD=STOR1*STOR1+STOR2*STOR2
3310       DO 107 J=1,MY
3320       STO1=C1(K,J)
3330       STO2=C2(K,J)
3340       C1(K,J)=C1(M,J)
3350       C2(K,J)=C2(M,J)
3360       C1(M,J)=(STO1*STOR1+STO2*STOR2)/SD
3370#107   C2(M,J)=(STO2*STOR1-STO1*STOR2)/SD
3380       C11=C1(M,M)
3390       C1(M,M)=(C1(M,M)*STOR1+C2(M,M)*STOR2)/SD
3400       C2(M,M)=(C2(M,M)*STOR1-C11*STOR2)/SD
3410       DO 118 I=1,MY
3420       IF(I-M) 112,118,112
3430#112   ST1=C1(I,M)
3440       ST2=C2(I,M)
3450       C1(I,M)=0
3460       C2(I,M)=0
3470       DO 110 J=1,MY
3480       C1(I,J)=C1(I,J)-C1(M,J)*ST1+C2(M,J)*ST2
3490       C2(I,J)=C2(I,J)-C2(M,J)*ST1-C1(M,J)*ST2
3500#110   CONTINUE
3510#118   CONTINUE
3520       DO 109 J=1,MY
3530#114   LRJ=LR(J)
3540       DO 113 I=1,MY
3550       T1=C1(I,LRJ)
3560       T2=C2(I,LRJ)
3570       C1(I,LRJ)=C1(I,J)
3580       C2(I,LRJ)=C2(I,J)
3590       C1(I,J)=T1
3600#113   C2(I,J)=T2
3610       L=LR(J)
3620       LR(J)=LR(LRJ)
3630       LR(LRJ)=L
3640       IF(J-LR(J)) 114,109,114
3650#109   CONTINUE
3660 300   IPIN=0
3663C
3664C
3665C      *** CALCULATE THE CURRENT AC,BC
3666C
3667C
3670 314   DO 65 I=1,MM
3680       AC(I)=0
3690       BC(I)=0
3700       DO 51 J=1,NN
3712       ABV=AV(J)**2+BV(J)**2
3714       IF(ABV.LT.1.E-8) GO TO 51
3716       K=IF(J)
3720       AC(I)=AC(I)+C1(I,K)*AV(J)-C2(I,K)*BV(J)
3725       BC(I)=BC(I)+C1(I,K)*BV(J)+C2(I,K)*AV(J)
3730#51    CONTINUE
3740#65    CONTINUE
3743C
3744C
3745C      *** CALCULATE THE INPUT POWER
3746C
3747C
3750       PIN=0.
3760       MX=1
3770       AA=1
3780       DO 240 I=1,NN
3790       K=IF(I)
3800       IF(NB.NE.0) GO TO 244
3810       IF(I.EQ.1) GO TO 242
3815       II=I-1
3820       MX=MX+NS(II)
3830#242   IF(K.EQ.MX.AND.Z(I).EQ.0..AND.GP.EQ.1.) AA=.5
3840#244   PIN=PIN+AA*(AC(K)*AV(I)+BC(K)*BV(I))
3845#246   CONTINUE
3862       IF(IRG.EQ.0) APIN=PIN
3865       IF(IRG.EQ.0) GO TO 316
3870       IPIN=IPIN+1
3880       IF(IPIN.GT.1) GO TO 316
3890       PSQ=SQRT(APIN/PIN)
3900       DO 312 I=1,NN
3910       AV(I)=AV(I)*PSQ
3920 312   BV(I)=BV(I)*PSQ
3930       IF(IPIN.EQ.1) GO TO 314
3940 316   IF(CL.EQ.0.) GO TO 70
3988C
3989C
3990C      *** CALCULATE THE COUPLING COEFFICIENT
3991C
3992C
4005       WRITE(2,63)
4010       WRITE(6,63)
4015#63    FORMAT(//' COUPLING COEFFICIENT')
4020       WRITE(2,120)
4025       WRITE(6,120)
4030#120   FORMAT(/' ANTENNA NO.      POWER RECEIVED (DB)')
4035       M=0
4040       DO 140 I=1,NB
4045       NX=1
4050       IF(IT(I).EQ.197) NX=26
4055       IF(IT(I).EQ.1097) NX=5
4060       PRE=0.
4065       DO 130 K=1,NX
```

```
4070        M=M+1
4075        IF(NX.EQ.26.AND.K.GT.2) GO TO 130
4080        J=L1(M)
4085        PRE=PRE+AZ(M)*(AC(J)*AC(J)+BC(J)*BC(J))
4090#130    CONTINUE
4095        IF(I.EQ.IW.OR.IT(I).EQ.1000) GO TO 140
4100        AA=PRE/PIN
4102        ADB=-100.
4105        IF(AA.GT.1.E-10) ADB=10.*ALOG10(AA)
4110        WRITE(2,125) I,ADB
4115        WRITE(6,125) I,ADB
4120#125    FORMAT(I6,13X,F10.2)
4125#140    CONTINUE
4190 70     IF(IFP.EQ.0) GO TO 82
4198C
4199C
4200C       *** CALCULATE THE VERTICAL RADIATION PATTERN
4201C
4202C
4220        WRITE(6,71)
4230        WRITE(2,71)
4240#71     FORMAT(//' VERTICAL PATTERN')
4250        WRITE(2,73) APHI
4260        WRITE(6,73) APHI
4270#73     FORMAT(/' PHI=',F7.1)
4280#74     FORMAT(/' THETA     NMAG      NMAG(DB)')
4290        AIT=181.
4300        IF(GP.EQ.1.) AIT=91
4305        AMAX=0.
4310        ATH=0.
4315        IY=1
4320        CALL PATT(APHI,ATH,IW,AIT,AINT,AMAX,APIN,ALT,IY,FA)
4390        WRITE(2,74)
4400        WRITE(6,74)
4410        CALL NPAT(AMAX,AIT,AINT)
4420 82     IF(IFT.EQ.0) GO TO 83
4423C
4424C
4425C       *** CALCULATE THE HORIZONTAL RADIATION PATTERN
4426C
4427C
4430        WRITE(6,201)
4440        WRITE(2,201)
4450#201    FORMAT(//' HORIZONTAL PATTERN')
4460        WRITE(2,81) ATHE
4470        WRITE(6,81) ATHE
4480#81     FORMAT(/' THETA=',F7.1)
4490#85     FORMAT(/'  PHI      NMAG      NMAG(DB)')
4500        AMAX=0.
4510        IY=2
4580        AIP=361.
4581        APH=0.
4582        CALL PATT(APH,ATHE,IW,AIP,AINP,AMAX,APIN,ALT,IY,FA)
4590        WRITE(2,85)
4600        WRITE(6,85)
4610        CALL NPAT(AMAX,AIP,AINP)
4615 83     IF(IRG.EQ.0) GO TO 100
4638C
4639C
4640C       *** CALCULATE THE COMMUNICATION RANGE CONTOUR
4641C
4642C
4650        WRITE(2,86)
4660        WRITE(6,86)
4670 86     FORMAT(//' COMMUNICATION RANGE CONTOUR')
4680        WRITE(2,99) (ALT(I),I=1,NA)
4690        WRITE(6,99) (ALT(I),I=1,NA)
4700 87     FORMAT(/' PHI(DEG)',12X,'RANGE(NM)')
4704        WRITE(2,87)
4706        WRITE(6,87)
4708 99     FORMAT(/'  ALT(FT)',6F8.1/(9X,6F8.1))
4710        IY=3
4720        CALL PATT(APHI,ATHE,IW,AIT,AINP,AMAX,APIN,ALT,IY,FA)
4730 100    CONTINUE
4895        STOP
4900        END
4910$      EXECUTE
5000$      LIMITS  50,55K
5010$      PRMFL   02,R/W,S,BLA00001/USAOUT1
5020$      PRMFL   01,R/W,S,BLA00001/USAIN1
5025$      PRMFL   03,R/W,R,BLA00001/DATAFILE
5030$      ENDJOB
```

METRIC SYSTEM

BASE UNITS:

Quantity	Unit	SI Symbol	Formula
length	metre	m	...
mass	kilogram	kg	...
time	second	s	...
electric current	ampere	A	...
thermodynamic temperature	kelvin	K	...
amount of substance	mole	mol	...
luminous intensity	candela	cd	...

SUPPLEMENTARY UNITS:

plane angle	radian	rad	...
solid angle	steradian	sr	...

DERIVED UNITS:

Acceleration	metre per second squared	...	m/s
activity (of a radioactive source)	disintegration per second	...	(disintegration)/s
angular acceleration	radian per second squared	...	rad/s
angular velocity	radian per second	...	rad/s
area	square metre	...	m
density	kilogram per cubic metre	...	kg/m
electric capacitance	farad	F	A·s/V
electrical conductance	siemens	S	A/V
electric field strength	volt per metre	...	V/m
electric inductance	henry	H	V·s/A
electric potential difference	volt	V	W/A
electric resistance	ohm		V/A
electromotive force	volt	V	W/A
energy	joule	J	N·m
entropy	joule per kelvin	...	J/K
force	newton	N	kg·m/s
frequency	hertz	Hz	(cycle)/s
illuminance	lux	lx	lm/m
luminance	candela per square metre	...	cd/m
luminous flux	lumen	lm	cd·sr
magnetic field strength	ampere per metre	...	A/m
magnetic flux	weber	Wb	V·s
magnetic flux density	tesla	T	Wb/m
magnetomotive force	ampere	A	...
power	watt	W	J/s
pressure	pascal	Pa	N/m
quantity of electricity	coulomb	C	A·s
quantity of heat	joule	J	N·m
radiant intensity	watt per steradian	...	W/sr
specific heat	joule per kilogram-kelvin	...	J/kg·K
stress	pascal	Pa	N/m
thermal conductivity	watt per metre-kelvin	...	W/m·K
velocity	metre per second	...	m/s
viscosity, dynamic	pascal-second	...	Pa·s
viscosity, kinematic	square metre per second	...	m/s
voltage	volt	V	W/A
volume	cubic metre	...	m
wavenumber	reciprocal metre	...	(wave)/m
work	joule	J	N·m

SI PREFIXES:

Multiplication Factors	Prefix	SI Symbol
$1\,000\,000\,000\,000 = 10^{12}$	tera	T
$1\,000\,000\,000 = 10^{9}$	giga	G
$1\,000\,000 = 10^{6}$	mega	M
$1\,000 = 10^{3}$	kilo	k
$100 = 10^{2}$	hecto*	h
$10 = 10^{1}$	deka*	da
$0.1 = 10^{-1}$	deci*	d
$0.01 = 10^{-2}$	centi*	c
$0.001 = 10^{-3}$	milli	m
$0.000\,001 = 10^{-6}$	micro	μ
$0.000\,000\,001 = 10^{-9}$	nano	n
$0.000\,000\,000\,001 = 10^{-12}$	pico	p
$0.000\,000\,000\,000\,001 = 10^{-15}$	femto	f
$0.000\,000\,000\,000\,000\,001 = 10^{-18}$	atto	a

* To be avoided where possible.

MISSION
of
Rome Air Development Center

RADC plans and conducts research, exploratory and advanced development programs in command, control, and communications (C^3) activities, and in the C^3 areas of information sciences and intelligence. The principal technical mission areas are communications, electromagnetic guidance and control, surveillance of ground and aerospace objects, intelligence data collection and handling, information system technology, ionospheric propagation, solid state sciences, microwave physics and electronic reliability, maintainability and compatibility.